Paleontological Research, vol. 5, no. 4, pp. 283–310, December 31, 2001

Middle Permian brachiopods from the Moribu area, Hida Gaien Belt, central Japan

JUN-ICHI TAZAWA

Department of Geology, Faculty of Science, Niigata University, Niigata 950-2181, Japan
(e-mail: tazawa@geo.sc.niigata-u.ac.jp)

Received May 11, 2001; Revised manuscript accepted 18 September 2001

Abstract. **A Middle Permian (Murgabian) brachiopod fauna is described from the lower Moribu Formation in the Moribu area, Hida Gaien Belt, central Japan. This fauna consists of 29 species, of which 2 are new, in 27 genera. The new species are *Fallaxoproductus moribuensis* and *Alispiriferella japonica*. The Moribu fauna is a Boreal-Tethyan mixed fauna and allied with the Middle Permian brachiopod faunas of central Japan (Ise in the Hida Gaien Belt), northeast Japan (South Kitakami Belt), eastern Russia (South Primorye), northeast China (Jilin) and north China (Inner Mongolia). These regions were probably a continental shelf bordering the northeastern margin of the Sino-Korean block, which was present at a middle northern palaeolatitude in the Middle Permian time.**

Key words: **Boreal-Tethyan mixed fauna, brachiopods, Hida Gaien Belt, Middle Permian, Moribu**

Introduction

The brachiopod fauna that is the subject of this paper was recovered from the lower member of the Moribu Formation in the Moribu area, about 10 km NE of Takayama, Hida Gaien Belt, central Japan (Figure 1). The Moribu Formation was named by Isomi and Nozawa (1957) for a Permian succession of the Hongo-Arakigawa area including the Moribu area. Since then the stratigraphy of the Moribu Formation has been discussed by Fujimoto *et al.* (1962), Yamada and Yamano (1980), Horikoshi *et al.* (1987), Tanase and Kasahara (1988), Tazawa (1996), and Yoshida and Tazawa (2000).

Faunal data for the Moribu Formation are included in several papers, fusulinaceans by Yamada and Yamano (1980) and Tazawa *et al.* (1993), radiolarians by Umeda and Ezaki (1997), corals by Yamada and Yamano (1980), and brachiopods by Horikoshi *et al.* (1987), Tazawa (1999a, b), and Shi and Tazawa (2001). To date, 5 fusulinacean and 3 brachiopod species have been described. Permian brachiopods of the Hida Gaien Belt are poorly known. Only one fauna, consisting of 13 species in 12 genera, was described by Tazawa and Matsumoto (1998) from the Oguradani Formation in the Ise area, about 80 km SW of Moribu. Thus, the Moribu fauna is the second-described but more plentiful Permian brachiopod fauna in the Hida Gaien Belt.

The purpose of the present study is to describe all available brachiopod elements of the Moribu fauna, and to discuss the age and palaeobiogeography of this fauna. The brachiopod fossils were collected from 10 localities in the Moribu area by E. Horikoshi (and his students), K. Tsushima, Y. Miyake and by myself in 1985-1999. All specimens described in this paper are housed in the Department of Geology, Faculty of Science, Niigata University.

Stratigraphy

Fossil localities, geological map and columnar sections of the Moribu Formation are shown in Figures 2–4, respectively. The Moribu Formation is distributed in the northwestern part of the Moribu area, having a general trend of NE-SW, and dipping towards the NW, although there are beds striking N-S or NW-SE and dipping W to SW in the eastern part. The Moribu Formation is composed of shallow marine continental shelf sediments and lithologically subdivided into three members, the lower shale-sandstone member (550 m thick) with some conglomerate and limestone beds, the middle sandstone member (230 m thick) with some tuffaceous sandstone beds, and the upper shale member (more than 650 m thick) with numerous, thin sandstone layers. The total thickness of this formation is more than 1,430 m. The Moribu Formation covers the Lower to Upper Carboniferous Arakigawa Formation with an unconformity, and is in turn unconformably overlain by the Upper Cretaceous-Palaeogene volcanic rocks (Nohi rhyolites). In general the Moribu Formation is sparsely fossiliferous. The lower member contains various marine invertebrate fossils, such as fusulinaceans, corals, bryozoans, brachiopods, bivalves, gastropods and crinoids. The middle member lacks macrofossils, but

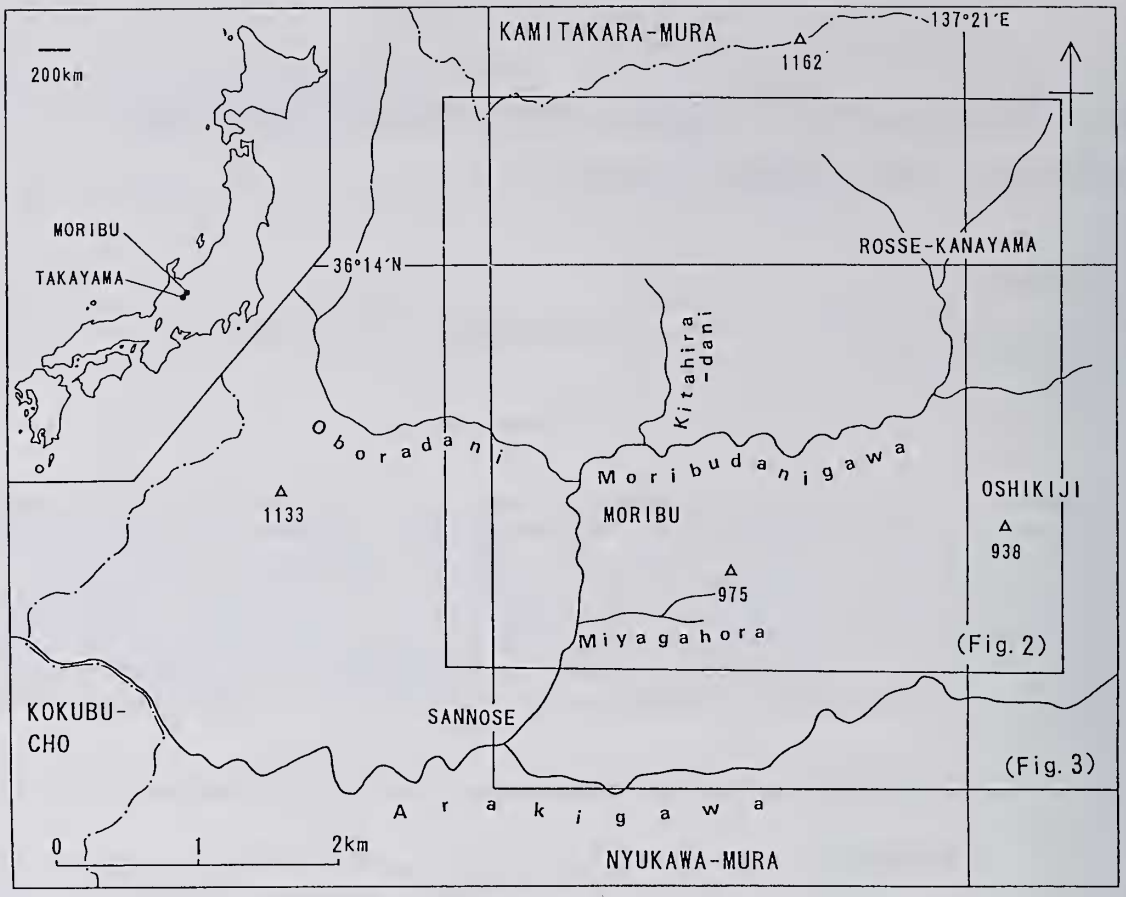


Figure 1. Index map showing the study area.

contains fusulinaceans and radiolarians in some horizons. The upper member is barren of fossils.

Brachiopods are the most common macrofossils. The brachiopod fossils treated in this paper were collected from the shale, sandstone and argillaceous impure limestone of the lower member at 10 localities (HMF1, 2, 3, 5, 8, 12, 13, 14, 16 and 25) (Figure 2). The topographical and stratigraphical positions, rock types and brachiopod lists of the collecting localities are as follows (see also Figure 4):

HMF1: Black shale, 10 m below the limestone of the lower member, at the left (east) bank of the lower Moribudanigawa River, 200 m S of a bridge in Moribu Village (Lat. 36° 12′ 41″ N, Long. 137° 19′ 10″ E); *Enteletes* sp., *Rhynchopora* sp., *Hustedia ratburiensis* Waterhouse and Piyasin, *Martiniopsis* sp., *Blasispirifer* cf. *reedi* (Licharew), and *Alispiriferella japonica* sp. nov.

HMF2: Dark grey argillaceous impure limestone, 4 m above the base of the limestone of the lower member, at the right (west) bank of the lower Moribudanigawa River, 30 m SW of HMF1; *Capillomesolobus* sp., *Transennatia gratiosa* (Waagen), *Reticulatia* sp., *Linoproductus lineatus* (Waagen), *Megousia* sp., *Cancrinella* cf. *spinosa* Hayasaka and Minato, *Urushtenoidea crenulata* (Ting), *Leptodus nobilis* (Waagen), *Derbyia* sp., *Stenoscisma margaritovi* (Tschernyschew), *Hustedia ratburiensis* Waterhouse and Piyasin, *Spiriferella lita* (Fredericks), and *Alispiriferella japonica* sp. nov.

HMF3: Black shale, 10 m above the calcareous conglomerate of the lower member, at the left bank of the middle Moribudanigawa River, 130 m W of the junction of the Kuragatani Valley and the Moribudanigawa River (Lat. 36° 13′ 24″ N, Long. 137° 20′ 42″ E); *Orbiculoidea* cf. *jangarensis* Ustritsky, *Stenoscisma margaritovi* (Tschernyschew), *Hustedia ratburiensis* Waterhouse and Piyasin, *Martinia* sp., *Blasispirifer* cf. *reedi* (Licharew), and *Dielasma* sp.

HMF5: Grey fine-grained sandstone, 65 m below the sandstone of the middle member, at the left bank of the upper Moribudanigawa River, 250 m NW of the junction of the Suganotani Valley and the Moribudanigawa River (Lat. 36° 14′ 17″ N, Long. 137° 20′ 29″ E); *Yakovlevia kaluzinensis* Fredericks, *Juresania* cf. *juresanensis* (Tschernyschew), *Hustedia ratburiensis* Waterhouse and Piyasin, *Gypospirifer volatilis* Duan and Li, and *Alispiriferella japonica* sp. nov.

HMF8: Black shale, 20 m below the limestone of the lower member, at 75 m upper from the entrance of a small tributary in the middle Moribudanigawa River, 250 m NE of HMF12; *Linoproductus lineatus* (Waagen), *Neospirifer* cf. *fasciger* (Keyserling), and *Alispiriferella japonica* sp. nov.

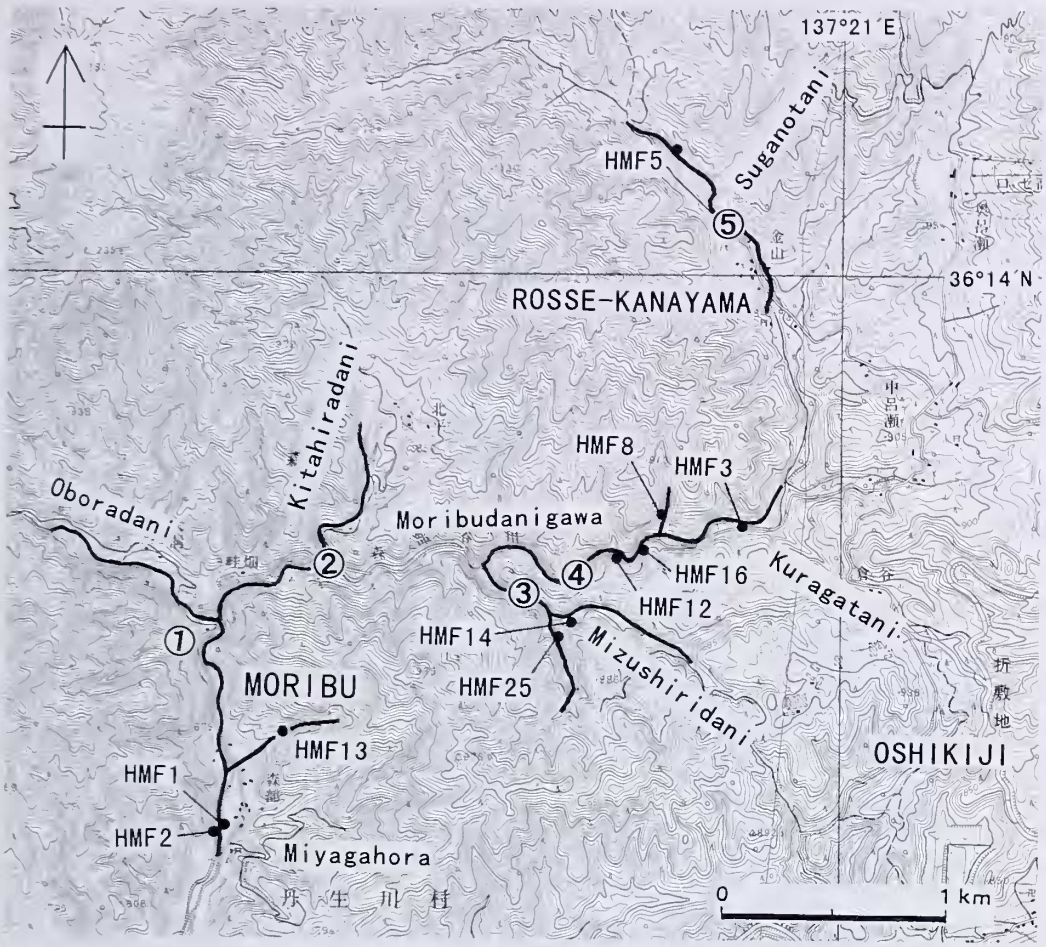


Figure 2. Index map showing the fossil localities (HMF1–3, 5, 8, 12–14, 16, 25) and the studied sections (①–⑤).

HMF12: Black shale, 5 m below the limestone of the lower member, at the left (south) bank of the middle Moribudanigawa River, 625 m E of the junction of the Mizuyagadani Valley and the Moribudanigawa River (Lat. 36° 13´ 20´´ N, Long. 137° 20´ 21´´ E); *Yakovlevia kaluzinensis* Fredericks, *Waagenoconcha permocarbonica* Ustritsky, *Waagenoconcha* cf. *imperfecta* Prendergast, *Fallaxoproductus moribuensis* sp. nov., *Permundaria asiatica* Nakamura, Kato and Choi, *Gypospirifer volatilis* Duan and Li, and *Alispiriferella ordinaria* (Einor).

HMF13: Black shale of the same horizon as HMF1, at the eastern slope facing the lower Moribudanigawa River, 500 m NNE of HMF1; *Transennatia gratiosa* (Waagen).

HMF14: Black shale, 10 m below the limestone of the lower member, at the middle Mizushiridani Valley, 500 m SE of the junction of the Mizushiridani Valley and the Moribudanigawa River (Lat. 36° 13´ 10´´ N, Long. 137° 20´ 12´´ E); *Yakovlevia kaluzinensis* Fredericks and *Alispiriferella japonica* sp. nov.

HMF16: Black shale of the same horizon of HMF8, at the left (east) bank of the middle Moribudanigawa River, 125 m NE of HMF12; *Alispiriferella japonica* sp. nov.

HMF25: Black shale, 30m below the limestone of the lower member, at 100 m SW of HMF14; *Yakovlevia kaluzinensis* Fredericks and *Gypospirifer volatilis* Duan and Li.

The Moribu fauna

Age and Correlation

The brachiopod fauna described here includes the following 29 species assigned to 27 genera: *Orbiculoidea* cf. *jangarensis* Ustritsky, *Capillomesolobus* sp., *Transennatia gratiosa* (Waagen), *Yakovlevia kaluzinensis* Fredericks, *Reticulatia* sp., *Juresania* cf. *juresanensis* (Tschernyschew), *Waagenoconcha permocarbonica* Ustritsky, *Waagenoconcha* cf. *imperfecta* Prendergast, *Linoproductus lineatus* (Waagen), *Megousia* sp., *Cancrinella* cf. *spinosa* Hayasaka and Minato, *Fallaxoproductus moribuensis* sp. nov., *Permundaria asiatica* Nakamura, Kato and Choi, *Urushtenoidea crenulata* (Ting), *Leptodus nobilis* (Waagen), *Derbyia* sp., *Enteletes* sp., *Stenoscisma margaritovi* (Tschernyschew), *Rhynchopora* sp., *Hustedia ratburiensis* Waterhouse and Piyasin, *Martinia* sp., *Martiniopsis* sp., *Neospirifer* cf. *fasciger* (Keyserling), *Blasispirifer* cf. *reedi* (Licharew), *Gypospirifer volatilis* Duan and Li, *Spiriferella lita* (Fredericks), *Alispiriferella ordinaria* (Einor), *Alispiriferella japonica* sp. nov. and *Dielasma* sp.

The list suggests a Middle Permian age, and certain taxa further suggest a narrower age ranging from the Murgabian

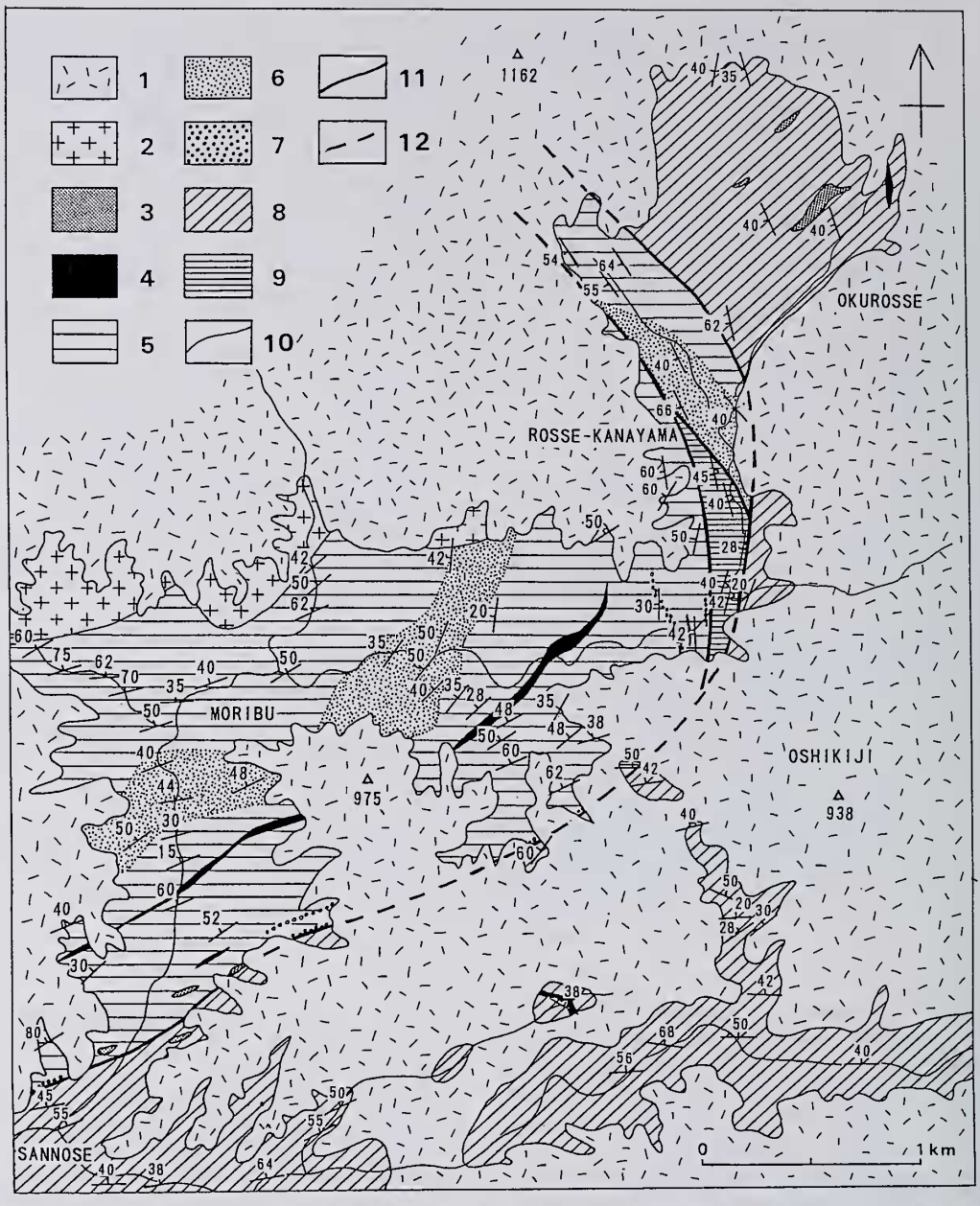


Figure 3. Geological map of the Moribu area (after Tazawa, Hasegawa and Yoshida, 2000). 1: Late Cretaceous and Palaeogene volcanic rocks, 2: Jurassic granitic rocks, 3: Dyke rocks, 4: Limestone of the Arakigawa and Moribu Formations, 5: Shale-dominant facies of the Moribu Formation, 6: Sandstone of the Moribu Formation, 7: Conglomerate of the Moribu Formation, 8: Arakigawa Formation (Carboniferous), 9: Rosse Formation (Devonian), 10: Unconformity, 11: Fault, 12: Concealed fault.

to the Midian. *Gypospirifer volatilis* has been known only from the Murgabian of Inner Mongolia. *Cancrinella* cf. *spinosa, Rhynchopora* sp. and *Blasispirifer* cf. *reedi* are similar to the Murgabian species. *Permundaria asiatica, Urushtenoidea crenulata, Stenoscisma margaritovi* and *Spiriferella lita* are elsewhere known from the Murgabian-Midian. *Yakovlevia kaluzinensis* is known from the Kubergandian-Midian. *Transennatia gratiosa* occurs in the Murgabian-Dzhulfian. *Waagenoconcha permocarbonica* has a long range from the Middle Carboniferous to the Middle Permian, but the lineage is restricted up to the Murgabian. *Linoproductus lineatus* is a long ranging species from the Middle Carboniferous to the Upper Permian, but most common in the Middle Permian. *Leptodus nobilis* ranges into the Kubergandian-Dorashamian. *Hustedia ratburiensis* is recorded from the Yakhtashian-Dzhulfian.

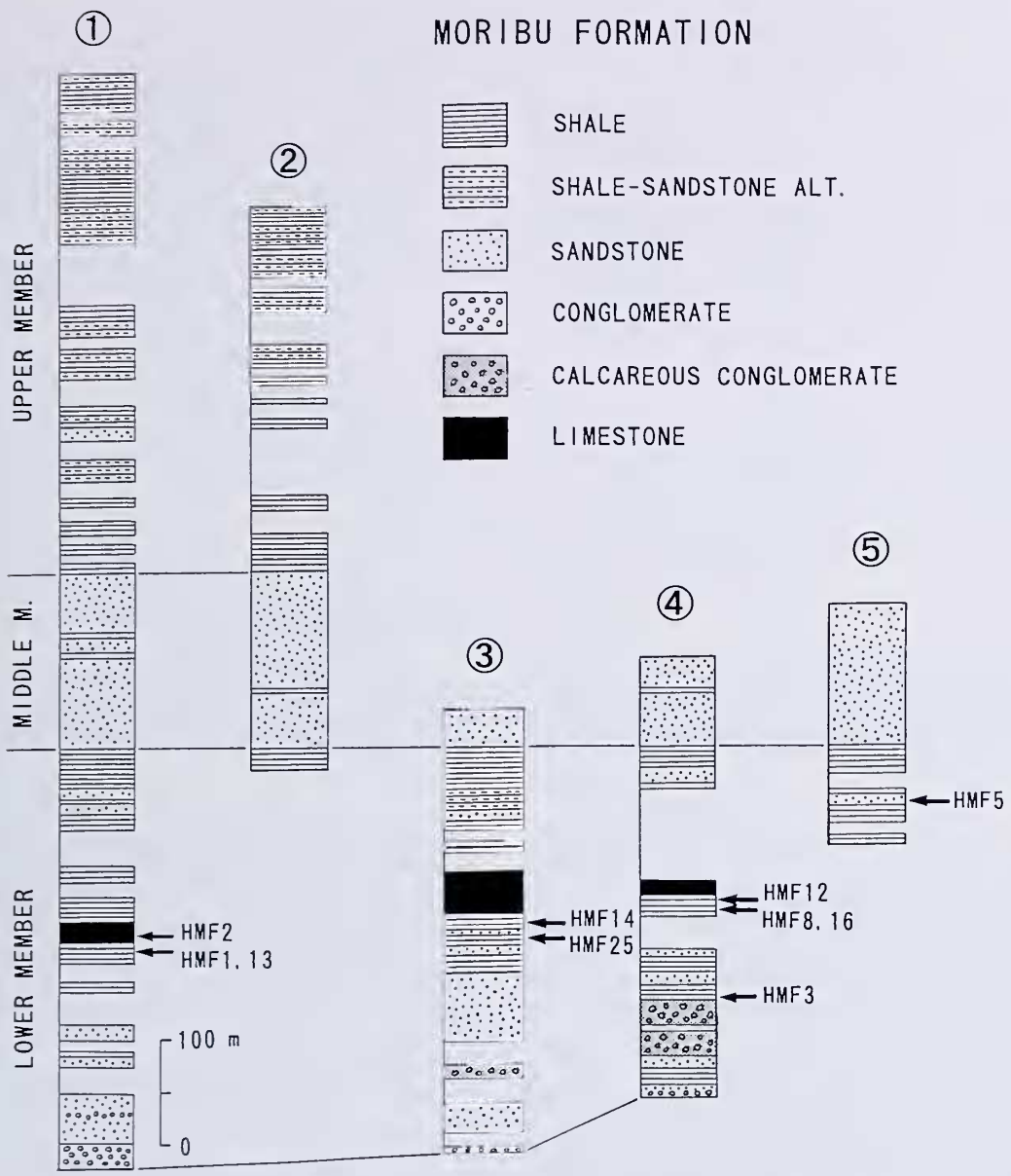


Figure 4. Columnar sections of the Moribu Formation, showing the stratigraphic positions of the fossil localities (HMF1-3, 5, 8, 12-14, 16, 25).

From this evidence, the Moribu fauna can be regarded as Murgabian in age. The Murgabian age assignment does not conflict with data from other fossils of the Moribu Formation.

Published data on fusulinaceans indicate similar age to that shown by brachiopods. The brachiopods occur from the middle and upper parts of the lower member of the Moribu Formation, i.e., the horizons between the calcareous conglomerate of the lower member, with *Pseudofusulina fusiformis* (Schellwien and Dyhrenfurth) and *Misellina* sp., described by Yamada and Yamano (1980), and the sandstone of the middle member, with *Monodiexodina* cf. *matsubaishi* (Fujimoto), described by Tazawa *et al.* (1993). These fusulinaceans confine the age of the brachiopod fauna between the Kubergandian and Murgabian. Consequently the age of the Moribu fauna is judged to be the Murgabian.

In generic and specific composition, the Moribu fauna is most similar to the Middle Permian brachiopod faunas from the Oguradani Formation of the Ise area, Hida Gaien Belt, central Japan (Tazawa and Matsumoto, 1998), and the Barabash and Chandalaz Formations of South Primorye, eastern Russia (Fredericks, 1924, 1925; Licharew and Kotlyar, 1978; Koczyrkevicz, 1979a, b). Furthermore, the

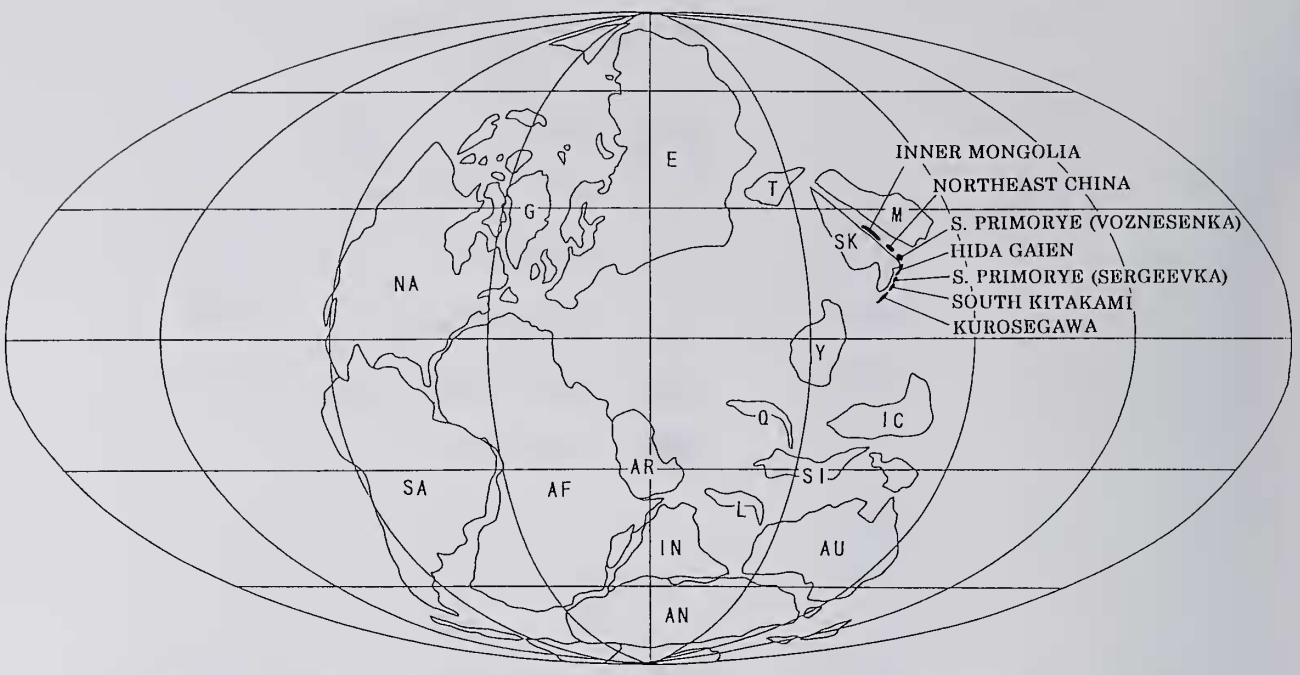


Figure 5. Palaeogeographical map in the Middle Permian time (adapted from Ziegler *et al.*, 1996). Black areas are continental shelf. AF: Africa, AN: Antarctica, AR: Arabia, AU: Australia, E: Eurasia, G: Greenland, IC: Indochina, IN: India, L: Lhasa, M: Mongolia, NA: North America, Q: Qiangtang, SA: South America, SI: Sibumasu, SK: Sino-Korea, T: Tarim, Y: Yangtze.

Middle Permian brachiopod faunas from the South Kitakami Belt (Hayasaka, 1925, 1960; Hayasaka and Minato, 1956; Nakamura *et al.*, 1970; Nakamura, 1979; Tazawa, 1979; Tazawa *et al.*, 2000), Jilin, northeast China (Lee *et al.*, 1980) and Inner Mongolia, north China (Grabau, 1931; Lee and Gu, 1976; Lee *et al.*, 1982; Duan and Li, 1985) also closely resembles the Moribu fauna in species composition.

Palaeobiogeography of the fauna

Palaeobiogeographically, the Moribu fauna contains rather numerous Boreal or bipolar (anti-tropical) elements, *Yakovlevia kaluzinensis, Waagenoconcha permocarbonica, Waagenoconcha* cf. *imperfecta, Megousia* sp., *Cancrinella* cf. *spinosa, Fallaxoproductus moribuensis, Stenoscisma margaritovi, Rhynchopora* sp., *Hustedia ratburiensis, Blasispirifer* cf. *reedi, Gypospirifer volatilis, Spiriferella lita, Alispiriferella ordinaria*, and *Alispiriferella japonica*. The Tethyan elements are also present but not abundant in this fauna. The Tethyan-type species in this fauna are *Transennatia gratiosa, Permundaria asiatica, Urushtenoidea crenulata, Leptodus nobilis*, and *Enteletes* sp. Consequently, the Moribu fauna is a mixture of the Boreal (bipolar or anti-tropical) and Tethyan elements, although the Boreal elements are predominant.

The Hida Gaien Belt with the Moribu fauna is restricted geographically to a continental shelf in the transitional zone between the Boreal and Tethyan Realms in east Asia, i.e., the Inner Mongolian-Japanese Transition Zone of Tazawa (1991, 1998), which includes Inner Mongolia, northeast China, South Primorye, Hida Gaien and South Kitakami, and placed on the northeastern margin of the Sino-Korean block in the middle palaeolatitude of the Northern Hemisphere during the Permian (Figure 5). The Hida Gaien Belt was probably located between the Voznesenka Belt (Barabash-Vladivostok area) and the Sergeevka Belt (Nakhodka-Paltizansk area), and more northerly than the South Kitakami, as mentioned by Tazawa (2001).

Systematic descriptions

Order Lingulida Waagen, 1885
Superfamily Discinoidea Gray, 1840
Family Discinidae Gray, 1840
Genus ***Orbiculoidea*** d'Orbigny, 1847

Type species.—*Orbicula forbesii* Davidson, 1848.

Orbiculoidea cf. ***jangarensis*** Ustritsky, 1960

Figure 6.11

Compare.—
Orbiculoidea jangarensis Ustritsky, 1960, p. 98, pl. 1, figs. 10–12; Ustritsky and Tschernjak, 1963, p. 68, pl. 1, figs. 5–9; Ifanova, 1972, p. 84, pl. 1, figs. 26–27; Kalashnikov, 1983, p. 204, pl. 45, figs. 3, 4; Kalashnikov, 1993, p. 14, pl. 2, fig. 13; pl. 3, figs. 5a, b; pl. 4, figs. 3a, b.

Material.—One specimen, from locality HMF3, external mould of a ventral valve, NU-B370.

Remarks.—This specimen is assigned to the genus *Orbiculoidea* due to its elliptical outline, short pedicle opening (7 mm long) and numerous, fine concentric lirae on the ventral valve. The Moribu species is a large *Orbiculoidea* of about 30 mm in diameter, and most resembles *Orbiculoidea jangarensis* Ustritsky, 1960, originally described by Ustritsky (1960) from the Talatin Formation of Pay Khoy, Pechora Basin, northern Russia in size and external ornament. *O. jangarensis* has been known from the Upper Artinskian to the Ufimian of the Pechora Basin and Taimyr Peninsula (Ustritsky, 1960; Ustritsky and Tschernjak, 1963; Ifanova, 1972; Kalashnikov, 1983, 1993).

Orbiculoidea sp. Hayasaka (1963, p. 479, figs. 1a, b), from the lower Kanokura Formation of the southern Kitakami Mountains (South Kitakami Belt), northeast Japan, is also close to the present species in size and external ornament of the ventral valve. But accurate comparison is difficult for the fragmentary specimen.

Order Productida Sarytcheva and Sokolskaya, 1959
Suborder Chonetidina Muir-Wood, 1955
Superfamily Chonetoidea Bronn, 1862
Family Rugosochonetidae Muir-Wood, 1962
Subfamily Capillomesolobinae Pecar, 1986
Genus ***Capillomesolobus*** Pecar, 1986

Type species.—*Capillomesolobus karavankensis* Pecar, 1986.

Capillomesolobus sp.

Figure 6.8a-6.10

Material.—Three specimens, from locality HMF2: (1) external and internal moulds of two ventral valves, NU-B371, 372; (2) external mould of a ventral valve, NU-B373.

Description.—Shell medium size for genus, transverse outline; length about 12 mm, width 14 mm+ in the best preserved specimen (NU-B371). Ventral valve gently and evenly convex in lateral profile; sulcus with median fold occupying whole length of sulcus. External surface of ventral valve ornamented by numerous capillae, having a density of 6 per 1 mm near anterior margin.

Remarks.—This species resembles the shells, described as *Mesolobus sinuosa* (Schellwien, 1898) by Hayasaka (1925, p. 93, pl. 5, figs. 5, 6) and *Mesolobus* sp. by Tazawa (1979, p. 25, pl. 4, figs. 2a, b), from the lower Kanokura Formation of the southern Kitakami Mountains, in size of ventral valve and characters of sulcus. But the Moribu specimens are inadequate for detailed comparison.

Suborder Productidina Waagen, 1883
Superfamily Productoidea Gray, 1840
Family Productellidae Schuchert, 1929
Subfamily Marginiferinae Stehli, 1954
Tribe Paucispiniferini Muir-Wood and Cooper, 1960
Genus ***Transennatia*** Waterhouse, 1975

Type species.—*Productus gratiosus* Waagen, 1884.

Transennatia gratiosa (Waagen, 1884)

Figure 6.1-6.7

Productus gratiosus Waagen, 1884, p. 691, pl. 72, figs. 3-7; Diener, 1897, p. 23, pl. 3, figs. 3-7; Mansuy, 1913, p. 115, pl. 13, figs. 1a, b; Colani, 1919, p. 10, pl. 1, figs. 2a-c; Chao, 1927, p. 44, pl. 4, figs. 6-10; Chi-Thuan, 1962, p. 491, pl. 2, figs. 5-7.

Productus (*Dictyoclostus*) *gratiosus* Waagen. Huang, 1933, p. 88, pl. 11, figs. 14a, b; Hayasaka, 1960, p. 49, pl. 1, fig. 8.

Marginifera gratiosa (Waagen). Reed, 1944, p. 98, pl. 19, figs. 6-7.

Dictyoclostus gratiosus (Waagen). Zhang and Ching, 1961, p. 411, pl. 4, figs. 12-18; Wang *et al.*, 1964, p. 291, pl. 45, figs. 14-19.

Gratiosina gratiosa (Waagen). Grant, 1976, pl. 33, figs. 19-26; Licharew and Kotlyar, 1978, pl. 12, figs. 5, 6; pl. 20, figs. 1a, b; Minato *et al.*, 1979, pl. 61, figs. 11-13.

Asioproductus gratiosus (Waagen). Yang *et al.*, 1977, p. 350, pl. 140, figs. 5a-c; Feng and Jiang, 1978, p. 254, pl. 90, figs. 1-2; Tong, 1978, p. 228, pl. 80, figs. 7a, b; Lee *et al.*, 1980, p. 373, pl. 164, figs. 14a-c; pl. 166, figs. 5-6.

Asioproductus bellus Chan (Zhan), 1979, p. 85, pl. 6, figs. 7-13; pl. 9, figs. 8-10; text-fig. 18.

Gratiosina sp. Minato *et al.*, 1979, pl. 61, fig. 14; Tazawa, 1991, p. 215.

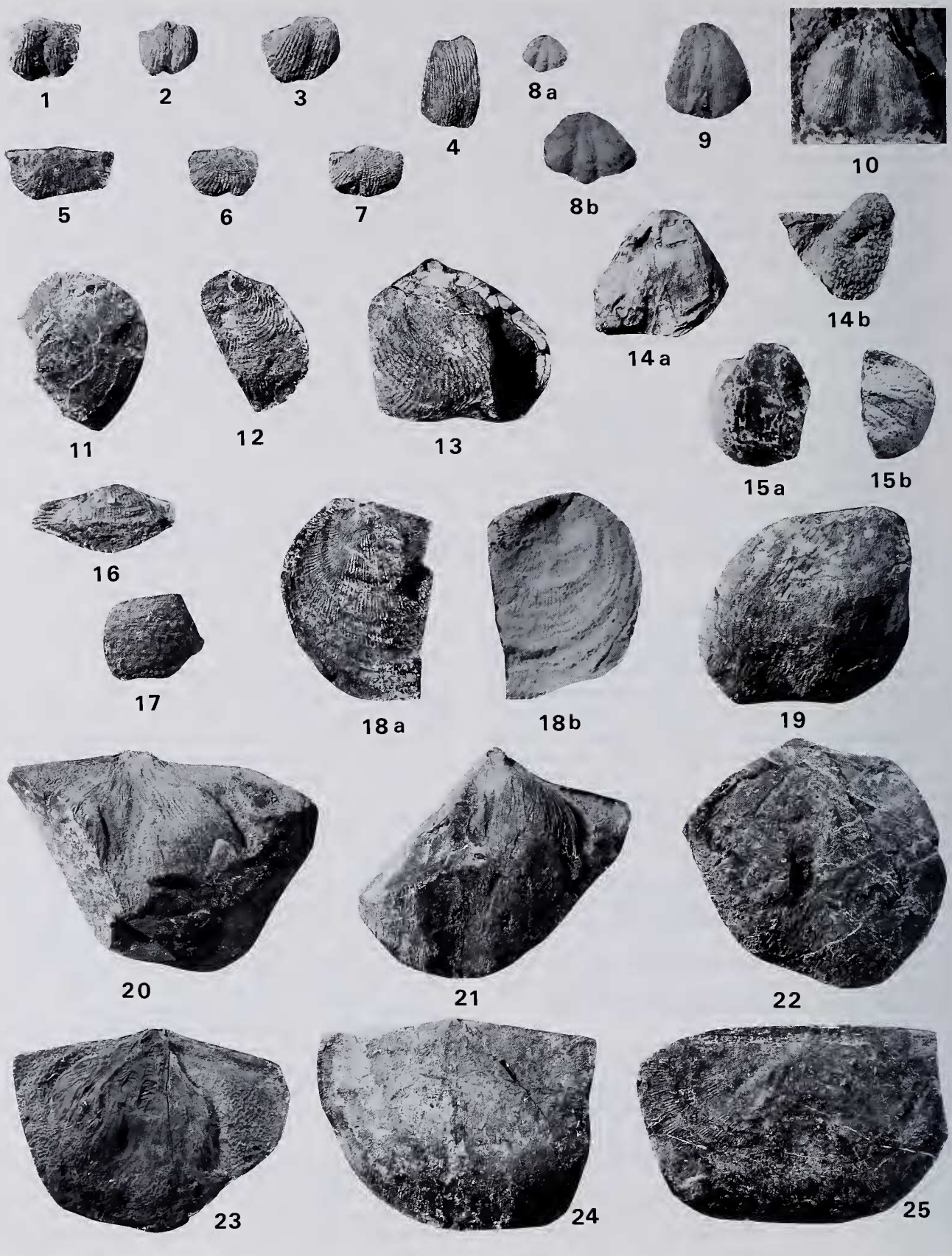
Transennatia gratiosus (Waagen). Liu *et al.*, 1982, p. 185, pl. 132, figs. 9a-d; Wang et al., 1982, p. 214, pl. 92, figs. 6-8; pl. 102, figs. 4-9; Ding and Qi, 1983, p. 280, pl. 95, figs. 14a, b.

Transennatia gratiosa (Waagen). Yang, 1984, p. 219, pl. 33, figs. 7a-c; Jin, 1985, pl. 4, figs. 33, 34, 45, 46; Tazawa and Matsumoto, 1998, p. 6, pl. 1, figs. 4-8; Tazawa, Takizawa and Kamada, 2000, p. 7, pl. 1, figs. 3-5; Tazawa, 2000, figs. 3.6, 3.7; Tazawa and Ibaraki, 2001, p. 7, pl. 1, figs. 1-3.

Material.—Ten specimens, from localities HMF2, 13: (1) external and internal moulds of two ventral valves, NU-B374, 375; (2) external casts of two ventral valves, NU-B376, 377; (3) external mould of a ventral valve, NU-B378; (4) internal moulds of two ventral valves, NU-B379, 380; (5) external moulds of three dorsal valves, NU-B381-383.

Description.—Shell small for genus, transversely subquadrate in outline, widest at hinge; length 9 mm, width 11 mm in the best preserved ventral valve specimen (NU-B374); length 11 mm+, width 21 mm in the largest dorsal valve specimen (NU-B382). Ventral valve strongly and unevenly convex in lateral profile, most convex at umbonal region, slightly geniculated at anterior margin of visceral disc, with long trail; umbo small, slightly incurved; ears small, distinct and pointed; sulcus narrow and deep; lateral slopes steep. Dorsal valve almost flat on visceral disc, slightly geniculated at anterior margin of visceral disc, followed by short trail; fold narrow and low. External surface of ventral valve reticulate on visceral disc, costate on trail; costae converging into sulcus anteriorly, having a density of 7-8 per 5 mm at midtrail; spines or spine bases not observed. External ornament of dorsal valve similar to that of opposite valve.

Remarks.—*Transennatia gratiosa* (Waagen, 1884) was originally described by Waagen (1884) from the Wargal and Chhidru Formations of the Salt Range. The Moribu specimens are smaller than the Salt Range specimens, and most resemble the smaller shells of *T. gratiosa,* from the Middle


1
2
3
4
8a
9
10
5
6
7
8b
14b
14a
11
12
13
15a
15b
16
17
18a
18b
19
20
21
22
23
24
25

Permian (Murgabian-Midian) of the southern Kitakami Mountains (Hayasaka, 1960, p. 49, pl. 1, fig. 8), South Primorye, eastern Russia (Licharew and Kotlyar, 1978, pl. 12, figs. 5, 6; pl. 20, figs. 1a, b) and Heilongjiang and Jilin, northeast China (Lee *et al.*, 1980, p. 373, pl. 164, figs. 14 a–c; pl. 166, figs. 5, 6).

Transennatia insculpta (Grant, 1976, p. 135, pl. 32, figs. 1–37; pl. 33, figs. 1-16) from the Rat Buri Limestone of Ko Muk, southern Thailand, is close to *T. gratiosa* in general appearance, but has wider shell and more prominent ears.

Transennatia huananensis (Zhan, 1979, p. 86, pl. 6, figs. 14–16) from the Longtan Formation of Guangdong, south China, is also a small *Transennatia*, but the Chinese species differs from *T. gratiosa* in having finer costae on the ventral valve.

Distribution. — Middle Permian (Murgabian-Midian) of Nepal (Kumaon Himalayas), Cambodia (Sisophon), Vietnam (Quang Tri), south China (Guangxi, Hubei and Shaanxi), northeast China (Jilin and Heilongjiang), eastern Russia (South Primorye) and Japan (Hida Gaien and South Kitakami Belts); Middle Permian (Murgabian) to Upper Permian (Dzhulfian) of Pakistan (Salt Range); Upper Permian (Dzhulfian) of south China (Sichuan, Guizhou, Guangdong, Hunan, Hubei, Jiangxi, Zhejiang and Anhui).

Subfamily Plicatiferinae Muir-Wood and Cooper, 1960
Tribe Yakovleviini Waterhouse, 1975
Genus ***Yakovlevia*** Fredericks, 1925

Type species.—*Yakovlevia kaluzinensis* Fredericks, 1925.

Yakovlevia kaluzinensis Fredericks, 1925

Figure 6.20–6.25

Chonetes (*Yakovlevia*) *kaluzinensis* Fredericks, 1925, p. 7, pl. 2, figs. 64–66.

Yakovlevia kaluzinensis Fredericks. Muir-Wood and Cooper, 1960, pl. 133, figs. 5, 6; Kotlyar, 1961, figs. 1–3; Licharew and Kotlyar, 1978, pl. 14, figs. 1, 2; Manankov, 1998, pl. 8, figs. 18, 19; Tazawa, 1999a, figs. 2.4–6; Tazawa, 1999b, p. 90, figs. 3.7–15; Tazawa, 2000, fig. 3.18.

Yakovlevia sp. Horikoshi *et al.*, 1987, figs. 3A, B; Tazawa, 1987, fig. 1.7.

Material.—Fourteen specimens, from localities HMF5, 12, 14, 25: (1) external mould of a dorsal valve and associated internal mould of the conjoined valve, NU-B192; (2) external and internal moulds of a ventral valve, NU-B157; (3) internal moulds of seven ventral valves, NU-B158-160, 193-196; (4) external moulds of three dorsal valves, NU-B163, 164, 191; (5) internal moulds of two dorsal valves, NU-B161, 162.

Description.—Shell large for genus, transversely rectangular in outline, with greatest width at hinge; length about 37 mm, width about 44 mm in the smaller, but well preserved ventral valve specimen (NU-B157); length about 47mm, width about 64 mm in the largest dorsal valve specimen (NU-B191).

Ventral valve gently convex on venter, strongly geniculated and followed by long trail; umbo small; ears large, prominent, but not clearly differentiated from visceral part; sulcus narrow and shallow, originating near umbo and extending to anterior margin. External ornament of ventral valve invisible except for a row of oblique spines just anterior to posterior margin. Dorsal valve almost flat on venter and strongly geniculated; fold narrow and low on anterior half of valve. External surface of dorsal valve ornamented by numerous fine costellae, with a density of 11–13 per 5 mm at midvalve.

Ventral valve interior with a pair of small, elongate subtrigonal adductor scars and two large diductor scars; diductor scars striated anteriorly and demarcated by a strong ridge posterolaterally. Internal structures of dorsal valve obscure in the present material.

Remarks. — The Moribu specimens are referred to *Yakovlevia kaluzinensis* Fredericks, 1925, originally described by Fredericks (1925) from the Chandalaz Formation of the Vladivostok area, South Primorye in size and shape of the shells, in particular, the transversely rectangular outline.

Yakovlevia impressa (Toula, 1875, p. 236, pl. 5, figs.1a–c) from the Middle Permian of Spitsbergen differs from *Y. kaluzinensis* in having larger and more prominent ears.

Distribution.—Middle Permian (Kubergandian-Midian) of southeastern Mongolia (near Mt. Dzhirem-Ula), eastern Russia (South Primorye) and central Japan (Hida Gaien Belt).

Family Productidae Gray, 1840
Subfamily Dictyoclostinae Stehli, 1954
Genus ***Reticulatia*** Muir-Wood and Cooper, 1960

Type species.—*Productus huecoensis* King, 1931.

← **Figure 6. 1–7.** *Transennatia gratiosa* (Waagen), 1: Internal mould of a ventral valve, NU-B375, 2: Internal mould of a ventral valve, NU-B374, 3: External cast of a ventral valve, NU-B377, 4: External cast of a ventral valve, NU-B376, 5: External mould of a dorsal valve, NU-B382, 6: External mould of a dorsal valve, NU-B383, 7: External mould of a dorsal valve, NU-B381, **8a–10.** *Capillomesolobus* sp., 8a, 8b: External latex cast of ventral valve, NU-B373, (8b ×2), 9: External latex cast of a ventral valve, NU-B372, (×2), 10: Internal mould of a ventral valve, NU-B371, (×2), **11.** *Orbiculoidea* cf. *jangarensis* Ustritsky, external mould of a ventral valve, NU-B370, **12, 13.** *Reticulatia* sp., 12: External mould of a dorsal valve, NU-B477, 13: External mould of a dorsal valve, NU-B476, **14a–15b.** *Juresania* cf. *juresanensis* (Tschernyschew), 14a, 14b: Internal mould and external latex cast of a ventral valve, NU-B384, 15a, 15b: Internal mould and lateral view of external latex cast of a ventral valve, NU-B385, **16.** *Megousia* sp., external mould of a dorsal valve, NU-B404, **17.** *Cancrinella* cf. *spinosa* Hayasaka and Minato, external cast of a ventral valve, NU-B397, **18a–19.** *Linoproductus lineatus* (Waagen), 18a, 18b: External mould and external latex cast of a dorsal valve, NU-B396, 19: External cast of a ventral valve, NU-B395, **20–25.** *Yakovlevia kaluzinensis* Fredericks, 20: Internal mould of a ventral valve, NU-B158, 21: Internal mould of a ventral valve, NU-B159, 22: Internal mould of a ventral valve, NU-B160, 23: Internal mould of a ventral valve, NU-B193, 24: Internal mould of a dorsal valve, NU-B161, 25: External mould of a dorsal valve, NU-B163. (Natural size unless otherwise indicated).

Reticulatia sp.

Figure 6.12, 6.13

Material.—Two specimens, from locality HMF2, external moulds of two dorsal valves, NU-B476, 477.

Description.—Shell small for genus, slightly transverse subquadrate in outline; length about 29 mm, width about 34 mm in the larger specimen (NU-B476). Dorsal valve flat on disk, strongly geniculated and followed by short trail. External surface of dorsal valve ornamented by regular numerous rugae and costae on disc, costae only on trail; costae numbering 5 in 5 mm at anterior margin of disc. Internally, dorsal valve having strong cardinal process; other details not observed.

Remarks.—These specimens are safely assigned to the genus *Reticulatia* by its shape and external ornament of the dorsal valve. However, the specific identification is difficult because of the poor preservation.

Superfamily Echinoconchoidea Stehli, 1954
Family Echinoconchidae Stehli, 1954
Subfamily Juresaniinae Muir-Wood and Cooper, 1960
Tribe Juresaniini Muir-Wood and Cooper, 1960
Genus ***Juresania*** Fredericks, 1928

Type species.—*Productus juresanensis* Tschernyschew, 1902.

Juresania cf. ***juresanensis*** (Tschernyschew, 1902)

Figure 6.14a-6.15b

Compare.—

Productus juresanensis Tschernyschew, 1902, p. 276, 620, pl. 29, figs. 1-2; pl. 47, figs. 1-2; pl. 53, figs. 4a, b; Fredericks, 1925, p. 27, pl. 4, figs. 118, 119.

Buxtonia juresanensis (Tschernyschew). Chao, 1927, p. 81, pl. 8, figs. 4-8; Czarniecki, 1969, p. 282, pl. 7, figs. 1-10; pl. 8, figs. 1-5; pl. 9, figs. 1-5; Sarytcheva and Sokolskaya, 1952, p. 102, pl. 17, fig. 117.

Productus (*Juresania*) *juresanensis* (Tschernyschew). Ozaki, 1931, p. 107, pl. 10, figs. 5a-c.

Productus juresanensis typicus Miloradovich, 1935, p. 79, 140, pl. 5, figs. 22-26; text-fig. 29.

Juresania juresanensis (Tschernyschew). Grabau, 1936, p. 140, pl. 13, figs. 5-6; Gobbett, 1963, p. 82, pl. 4, figs. 34-37; Nakamura, 1959, p. 203, pl. 2, figs. 1a-c; Yanagida, 1967, p. 52, pl. 15, figs. 1-7; text-fig. 4; Kalashnikov, 1980, p. 40, pl. 8, figs. 10a-v; Lazarev, 1982, p. 70, pl. 8, figs. 8-11; Liu *et al.*, 1982, p. 207, pl. 79, figs. 10a-c; Zhang *et al.*, 1983, p. 293, pl. 131, figs. 2a, b; Zeng, 1990, p. 217, pl. 4, figs. 9a-c; Fan and He, 1999, p. 119, pl.10, figs. 9-10.

Material.—Two specimens, from locality HMF5, external and internal moulds of two ventral valves, NU-B384, 385.

Description.—Shell medium size for genus, longer than wide; length about 26 mm, width about 22 mm in the smaller but better preserved specimen (NU-B385). Ventral valve strongly convex in both lateral and anterior profiles, with small, convex ears, shallow sulcus and very steep lateral slopes. External ornament of ventral valve consisting of regular concentric bands and numerous spine bases of two sizes on them; smaller spine bases sometimes occur between larger ones on anterior half of valve.

Remarks.—In external character the Moribu specimens resemble well the ventral valves of *Juresania juresanensis* (Tschernyschew, 1902), from the Lower Permian Indiga Horizon of Timan (Tschernyschew, 1902, pl. 29, figs. 1a-c) and from the Maping Limestone of Yunnan Province, south China (Grabau, 1936, pl. 13, figs. 5-6). But the poor preservation of this material makes accurate comparison difficult. *J. juresanensis* has been described from the Middle Carboniferous (Moscovian) to the Middle Permian (Midian) of Spitsbergen, northern Russia (Novaya Zemlya, Urals, Timan, Kanin Peninsula and Moscow Basin), northern Thailand, south China (Yunnan), northwest China (Xinjiang and Gansu), north China (Inner Mongolia, Shanxi and Shandong), eastern Russia (South Primorye), and northeast Japan (South Kitakami Belt).

Tribe Waagenoconchini Muir-Wood and Cooper, 1960
Genus ***Waagenoconcha*** Chao, 1927

Type species.—*Productus humboldtii* d'Orbigny, 1842.

Waagenoconcha permocarbonica Ustritsky, in Ustritsky and Tschernjak, 1963

Figure 7.20-7.23

Waagenoconcha permocarbonica Ustritsky, in Ustritsky and Tschernjak, 1963, p. 79, pl. 7, fig. 6; pl. 8, figs. 1-3; Lee *et al.*, 1980, p. 364, pl. 168, figs. 1, 6; pl. 169, figs. 3, 4; Duan and Li, 1985, p. 107, pl. 37, figs. 3-5; Shi and Waterhouse, 1996, p. 77, pl. 9, figs. 4-15; pl. 10, figs. 1-4; Tazawa, 2000, figs. 3.16, 3.17.

Material.—Eight specimens, from locality HMF12: (1) external and internal moulds of a conjoined valve, NU-B386; (2) internal moulds of a conjoined valve, NU-B387; (3) external moulds of two ventral valves, NU-B388, 389; (4) external and internal moulds of two dorsal valves, NU-B390, 391; (5) external moulds of two dorsal valves, NU-B392, 393.

Description. — Shell large for genus, transverse, subrectangular in outline, with greatest width slightly anterior to midvalve; length 49 mm, width 51 mm in a ventral valve specimen (NU-B388). Ventral valve strongly convex in both lateral and anterior profiles, with steep lateral slopes; sulcus moderately developed, originating at about 8-10 mm from umbo, deepest at midvalve, and shallowing and widening anteriorly. Dorsal valve with low fold, flat on visceral disc, moderately geniculated, and followed by short trail. External surface of ventral valve ornamented by irregular concentric rugae and numerous, quincuncially arranged spine bases; spine bases becoming fine at anterolateral parts; numbering 5-6 in 5 mm at midvalve, 15-17 in 5 mm near anterior margin. External ornament of dorsal valve similar to that of opposite valve. Internal structures of both valves obscure.

Remarks.—These specimens are referred to *Waagenoconcha permocarbonica* Ustritsky, 1963, originally described by Ustritsky (in Ustritsky and Tschernjak, 1963) from the Bashkirian to the Sakmarian of Taimyr, on account of size,

shape and external ornament of both valves.

Waagenoconcha sp. B, described and figured by Liu and Waterhouse (1985, p. 15, pl. 2, figs. 3, 4) from the Middle Permian Zhesi (Jisu) Formation of Xiujimqinqi, Inner Mongolia, differs from the present species in its less transverse outline.

Waagenoconcha waageni (Rothpletz, 1892) from the Middle Permian of Timor is close in general outline, but it has more numerous and stronger concentric bands and coarser spine bases on the ventral valve (see Archbold and Bird, 1989, figs. 3C, D).

Distribution.—Middle Carboniferous (Bashkirian) to Lower Permian (Sakmarian) of northern Russia (Taimyr); Lower Permian (Sakmarian) of western Canada (Yukon Territory); Middle Permian (Kubergandian-Murgabian) of north China (Inner Mongolia), northeast China (Jilin and Heilongjiang) and central Japan (Hida Gaien Belt).

Waagenoconcha cf. ***imperfecta*** Prendergast, 1935

Figure 7.24a, 7.24b

Compare.—

Waagenoconcha imperfecta Prendergast, 1935, p. 15, pl. 4, figs. 1-3; Prendergast, 1943, p. 25, pl. 3, figs. 7-9; Coleman, 1957, p. 82, pl. 10, figs. 8-14; pl. 11, figs. 1-6; Tazawa, 1974b, p. 127, pl. 1, figs. 4-6; pl. 2, figs. 2-7; pl. 3, figs. 1-3; pl. 4, figs. 1-4, 7.

Waagenoconcha (*Wimanoconcha*) *imperfecta* Prendergast. Archbold, 1993, p. 20, figs. 11A-H, 12A-K, 13A-G.

Material.—One specimen, from locality HMF2, external and internal moulds of a dorsal valve, NU-B394.

Remarks.—The single dorsal valve specimen from Moribu is small in size (length 27 mm, width 29 mm), almost flat on venter, with a low and wide fold on the anterior half of the valve, weakly geniculated, and ornamented by numerous, fine, quincuncially arranged spine bases, having a density of 8 per 5 mm at the midvalve. This specimen may be a young shell of *Waagenoconcha imperfecta* Prendergast, 1935, which has been described from the Upper Permian (Dzhulfian) Hardman Formation of the Canning Basin, western Australia (Prendergast, 1935, 1943; Coleman, 1957; Archbold, 1993) and the Middle Permian (Murgabian) lower Kanokura Formation of the southern Kitakami Mountains, northeast Japan (Tazawa, 1974b). *W. imperfecta* is distinguished from any other waagenoconchids by its very fine and closely arranged spine bases on both the ventral and dorsal valves.

Superfamily Linoproductoidea Stehli, 1954
Family Linoproductidae Stehli, 1954
Subfamily Linoproductinae Stehli, 1954
Genus ***Linoproductus*** Chao, 1927

Type species.—*Productus cora* d'Orbigny, 1842.

Linoproductus lineatus (Waagen, 1884)

Figure 6.18a-6.19

Productus lineatus Waagen, 1884, p. 673, pl. 66, figs. 1-2; pl. 67, fig. 3; text-figs. 21a-d; Diener, 1903, p. 138, pl. 7, figs. 1a-c; Tschernyschew, 1914, p. 30, 63, pl. 10, figs. 1a-c.

Productus (*Linoproductus*) *lineatus* (Waagen). Grabau, 1931, p. 293, pl. 29, figs. 25-27.

Linoproductus lineatus (Waagen). Chao, 1927, p. 129, pl. 15, figs. 25-27; Ivanov, 1935, p. 105, pl. 5, fig. 6; pl. 6, figs. 1-4; Minato, 1943, p. 54, pl. 2, figs. 2-5; Sarytcheva and Sokolskaya, 1952, p. 115, pl. 21, fig. 149; Volgin, 1960, p. 70, pl. 7, figs. 2a-v; Lee and Gu, 1976, p. 259, pl. 162, fig. 10; Feng and Jiang, 1978, p. 260, pl. 92, figs. 4a, b; Licharew and Kotlyar, 1978, pl. 13, fig. 1; Tong, 1978, p. 231, pl. 81, figs. 7a, b; Lee *et al.*, 1980, p. 376, pl. 152, fig. 13; Yang, 1984, p. 222, pl. 34, figs. 14a, b; Sremac, 1986, p. 28, pl. 9, figs. 9a-c; Wang and Yang, 1998, p. 100, pl. 16, figs. 1, 3-6.

Linoproductus lineatus lineatus (Waagen). Ramovs, 1958, p. 515, 592, pl. 6, figs. 1a-c; pl. 7, figs. 1a-c; pl. 8, figs. 1a, b.

Linoproductus cf. *lineatus* (Waagen). Yanagida, 1963, p. 74, pl. 10, figs. 8-14.

Linoproductus lineata (Waagen). Ding and Qi, 1983, p. 291, pl. 99, figs. 3a-c.

Material.—Two specimens, from localities HMF2, 8: (1) external cast of a ventral valve, NU-B395; (2) external mould of a dorsal valve, NU-B396.

Remarks.—The specimens from Moribu are referred to *Linoproductus lineatus* (Waagen, 1884), originally described by Waagen (1884) from the Amb, Wargal and Chhidru Formations of the Salt Range, because of similarities in size, shape and external ornament. The ventral valve specimen (NU-B395) is elongate in outline (length 44 mm, width 40 mm), and has small ears and a shallow sulcus. The dorsal valve specimen (NU-B396) is also longer than wide, with a rather short hinge line, and ornamented by numerous costellae (8-10 per 5 mm at the midvalve) and irregular, strong concentric rugae.

The type species, *Linoproductus cora* (d'Orbigny, 1842), from the Lower Permian of Bolivia, differs from *L. lineatus* in its larger, transverse shell and in having much larger ears and lacking a ventral sulcus (see Muir-Wood and Cooper, 1960, pl. 111, figs. 3-6).

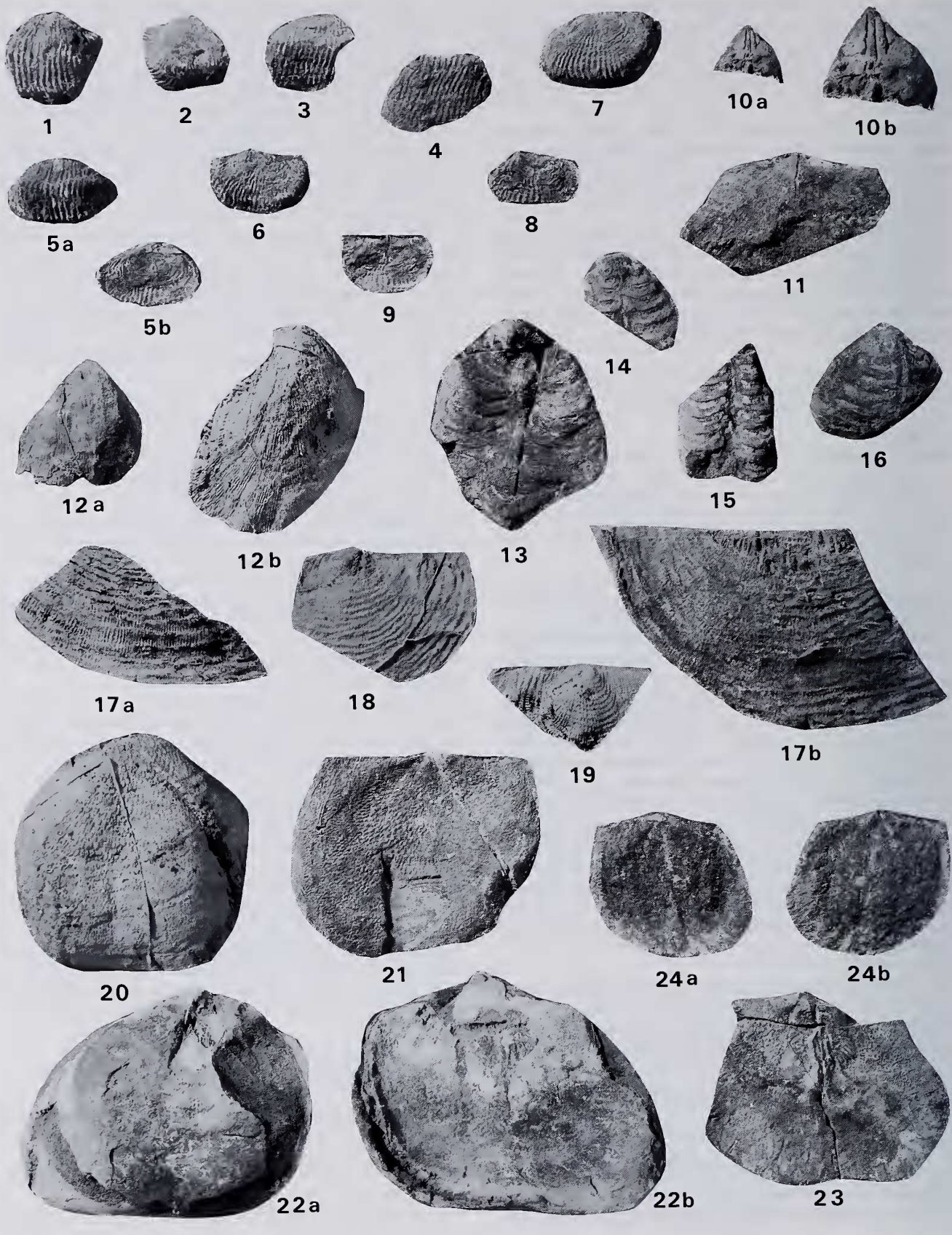
Distribution.—Middle Carboniferous (Moscovian) of northeast China (Jilin); Upper Carboniferous (Kasimovian-Gzhelian) of Russia (Moscow Basin and southern Fergana); Lower Permian of northwest China (Xinjiang); Lower Permian (Asselian) to Upper Permian (Dzhulfian) of Croatia, Pakistan (Salt Range), India (Spiti, Punjab Himalayas), Fergana, south China (Guizhou, Sichuan and Hubei), northwest China (Gansu), north China (Inner Mongolia), northeast China (Jilin), eastern Russia (South Primorye) and Japan (Mizukoshi in Kyushu Island and Moribu in the Hida Mountains).

Subfamily Anidanthinae Waterhouse, 1968
Genus ***Megousia*** Muir-Wood and Cooper, 1960

Type species.—*Megousia auriculata* Muir-Wood and Cooper, 1960.

Megousia sp.

Figure 6.16


1
2
3
4
7
10a
10b
5a
6
8
11
5b
9
14
12a
12b
13
15
16
17a
18
17b
19
20
21
24a
24b
22a
22b
23

Megousia sp. Tazawa, 2000, fig. 3.3.

Material.—One specimen, from locality HMF2, external mould of a dorsal valve, NU-B404.

Remarks.—This specimen is safely assigned to the genus *Megousia* on the basis of its small size, transversely elliptical outline (length 11 mm, width 26 mm), and in having greatly developed ears with radial ornament. The Moribu species superficially resembles *Megousia solita* Waterhouse (1968, p. 1172, pl. 154, figs. 1–6, 8–10), from the Middle Permian Ulladulla Formation of New South Wales, eastern Australia, but the material is too poor for comparison.

Megousia koizumii Nakamura (1972, p. 438, pl. 2, figs. 1, 4, 5), from the Middle Permian Kashiwadaira Formation of the Takakurayama area, Abukuma Mountains, northeast Japan, is clearly distinguished from the present species by its larger, recurved and hung down ears.

Subfamily Grandaurispininae Lazarev, 1986
Genus ***Cancrinella*** Fredericks, 1928

Type species.—*Productus cancrini* de Verneuil, 1845.

Cancrinella cf. ***spinosa*** Hayasaka and Minato, 1956

Figure 6.17

Comapare.—
Productus villiersi kozlowskianus Fredericks. Hayasaka, 1925, p. 96, pl. 5, figs. 10, 11.
Cancrinella cancriniformis spinosa Hayasaka and Minato, 1956, p. 144, pl. 23, figs. 4a, b.
Cancrinella spinosa Hayasaka and Minato. Tazawa, 1976, pl. 2, fig. 5; Minato *et al.*, 1979, pl. 62, figs. 5–8, 11.

Material.—One specimen, from locality HMF2, external cast of a ventral valve, NU-B397.

Remarks.—The fragmentarily preserved specimen is assigned to the genus *Cancrinella* on the basis of its small sized ventral valve (length 18 mm+, width 16 mm+), lacking sulcus, and ornamented by fine concentric rugae and numerous, quincuncially arranged spine bases on the venter.

This specimen can be safely assigned to the *Cancrinella cancriniformis* group of Grigoreva *et al.* (1977) by having distinct rugae on the ventral valve. Within the group, the Moribu species is closely allied to *Cancrinella spinosa* Hayasaka and Minato, 1956, described from the Middle Permian (Murgabian) lower Kanokura Formation of the southern Kitakami Mountains (Hayasaka, 1925; Hayasaka and Minato, 1956; Tazawa, 1976; Minato *et al.*, 1979) in size, shape and external ornament of the ventral valve.

Family Monticuliferidae Muir-Wood and Cooper, 1960
Subfamily Compressoproductinae Jin and Hu, 1978
Genus ***Fallaxoproductus*** Lee, Gu and Li, 1982

Type species.—*Fallaxoproductus sutungensis* Lee, Gu and Li, 1982.

Fallaxoproductus moribuensis sp. nov.

Figure 7.12a, 7.12b

Material.—Two specimens, from locality HMF12: (1) external and internal moulds of a ventral valve (holotype), NU-B398; (2) external mould of a ventral valve, NU-B399.

Diagnosis.—Shell medium size for genus, slightly elongate trigonal, with very fine costellae on ventral valve, having a density of 12–14 in 5 mm near anterior margin.

Description.—Shell small to medium for genus, slightly elongate trigonal in outline, with short hinge, greatest width near anterior margin; length about 39 mm, width about 32 mm in the holotype (NU-B398). Ventral valve strongly convex on umbonal slope and slightly convex to nearly flat on anterior half of valve; beak prominent, strongly incurved, but not overhanging hinge line; without ears and sulcus. External surface of ventral valve ornamented by regular, numerous, fine costellae, numbering 12–14 in 5 mm near anterior margin; spines clustering along lateral margins; rugae completely absent. Internal structures of ventral valve obscure in the present material.

Remarks.—*Fallaxoproductus moribuensis* sp. nov. can be differentiated from the type and two other described species, *F. dedorus* Lee, Gu and Li, 1982 and *F. plenus* Lee, Gu and Li, 1982, both from the Lower Permian of the Xiujimqinqi area, Inner Mongolia, by its fine costellae on the ventral valve.

The type species, *Fallaxoproductus sutungensis* Lee, Gu and Li, 1982, is much closer to *F. moribuensis* in size and outline of shell, but it differs from the latter in having fewer and more strong costellae on the ventral valve.

← **Figure 7.** **1–9.** *Urushtenoidea crenulata* (Ting), 1: Internal mould of a ventral valve, NU-B407, 2: Internal mould of a ventral valve, NU-B411, 3: Internal mould of a ventral valve, NU-B409, 4: Anterior view of internal mould of a ventral valve, NU-B405, 5a, 5b: Ventral and dorsal views of internal mould of a conjoined valve, NU-B406, 6: External mould of a dorsal valve, NU-B416, 7: External mould of a dorsal valve, NU-B415, 8: Internal mould of a dorsal valve, NU-B418, 9: Internal mould of a dorsal valve, NU-B417, **10a, 10b.** *Enteletes* sp., internal mould of a ventral valve, NU-B430, (10b ×2), **11.** *Derbyia* sp., internal mould of a ventral valve, NU-B429, **12a, 12b.** *Fallaxoproductus moribuensis* sp. nov., internal mould and external latex cast of a ventral valve, NU-B398 (holotype), **13–16.** *Leptodus nobilis* (Waagen), 13: Internal mould of a ventral valve, NU-B424, 14: Internal mould of a ventral valve, NU-B427, 15: Internal mould of a ventral valve, NU-B421, 16: Internal mould of a ventral valve, NU-B426, **17a–19.** *Permundaria asiatica* Nakamura, Kato and Choi, 17a, 17b: External latex cast and internal mould of a ventral valve, NU-B400, 18: External latex cast of a ventral valve, NU-B402, 19: External latex cast of a ventral valve, NU-B403, **20–23.** *Waagenoconcha permocarbonica* Ustritsky, 20: External latex cast of a ventral valve, NU-B388, 21: External mould of a dorsal valve, NU-B392, 22a, 22b: Ventral and dorsal views of internal mould of a conjoined valve, NU-B387, 23: Internal mould of a dorsal valve, NU-B390, **24a, 24b.** *Waagenoconcha* cf. *imperfecta* Prendergast, internal and external moulds of a dorsal valve, NU-B394. (Natural size unless otherwise indicated).

Subfamily Schrenkiellinae Lazarev, 1986
Genus ***Permundaria*** Nakamura, Kato and Choi, 1970

Type species.—*Permundaria asiatica* Nakamura, Kato and Choi, 1970.

Permundaria asiatica Nakamura, Kato and Choi, 1970

Figure 7.17a-7.19

Striatifera? sp. Hayasaka and Minato, 1956, p. 144, pl. 23, figs. 6, 7.
Permundaria asiatica Nakamura, Kato and Choi, 1970, p. 296, pl. 2, figs. 1, 2; Tazawa, 1974a, p. 315, pl. 43, figs. 3-4; Minato *et al.*, 1979, pl. 62, figs. 12, 13; Tazawa, 2000, fig. 3.4.

Material.—Four specimens, from locality HMF12, external and internal moulds of four ventral valves, NU-B400-403.

Remarks.—Among the specimens from Moribu, the largest ventral valve specimen (NU-B400) may have originally been about 45 mm long, and about 70 mm wide, although both the anterior portion and left half of the valve have been broken off. The valve is slightly convex in the lateral and anterior profiles, and is ornamented by irregularly developed and somewhat flexuous concentric rugae and numerous costellae, numbering 11-12 in 5 mm near the anteror margin. Another specimen (NU-B403) is also an imperfect ventral valve, but the posterior part is well preserved. The ventral valve has a straight hinge, large and flattened ears, and a small, pointed and slightly elevated umbo.

These specimens can be identified with *Permundaria asiatica* Nakamura, Kato and Choi, 1970 by having a small and pointed umbo, irregular and slightly flexuous rugae, and relatively coarse costellae on the ventral valves. *P. asiatica* was originally described by Nakamura *et al.* (1970, p. 296) based on two specimens, the holotype from the lower Kanokura Formation of the southern Kitakami Mountains, northeast Japan, and the paratype from the Sisophon Limestone (*Yabeina* Zone) of Sisophon, Cambodia. The present species is easily distinguished from the following three *Permundaria* species in having coarser costellae on both valves: *P. sisophonensis* Nakamura, Kato and Choi (1970, p. 297, pl. 2, figs. 3a, b) from the Sisophon Limestone of Cambodia, *P. tenuistriata* Tazawa (1974a, p. 317, pl. 43, figs. 1, 2) from the lower Kanokura Formation of the southern Kitakami Mountains, and *P. liaoningensis* Lee and Gu (in Lee *et al.*, 1980, p. 385, pl. 172, figs. 5-8) from the Lower Permian of Liaoning and Heilongjiang, northeast China.

Permundaria shizipuensis Jin, Liao and Fang (1974, p. 310, pl. 162, fig. 18) from the Maokou Formation of Guizhou, south China, differs from *P. asiatica* in having a massive and rounded umbo on the ventral valve.

Distribution. — Middle Permian (Murgabian-Midian) of Cambodia and Japan (South Kitakami and Hida Gaien Belts).

Suborder Strophalosiidina Schuchert, 1913
Superfamily Aulostegoidea Muir-Wood and Cooper, 1960
Family Aulostegidae Muir-Wood and Cooper, 1960
Subfamily Chonosteginae Muir-Wood and Cooper, 1960
Genus ***Urushtenoidea*** Jin and Hu, 1978

Type species.—*Urushtenia chaoi* Jin, 1963.

Urushtenoidea crenulata (Ting, in Yang *et al.*, 1962)

Figure 7.1-7.9

Eomarginifera crenulata Ting, in Yang *et al.*, 1962, p. 85, pl. 37, figs. 6 right-8.
Urushtenia costata Ting, in Yang *et al.*, 1962, p. 87, pl. 25, figs. 5-7; pl. 37, fig. 6 left.
Urushtenia chenanensis Chan, in Chan (Zhan) and Lee, 1962, p. 478, 488, pl. 3, figs. 4-6; Tong, 1978, p. 218, pl. 78, figs. 16a-c.
Urushtenia crenulata (Ting). Jin, 1963, p. 20, pl. 1, figs. 17-24; pl. 2, figs. 9, 10, 18-20; text-fig. 5; Yang *et al.*, 1977, p. 335, pl. 136, figs. 11a-c; Feng and Jiang, 1978, p. 246, pl. 89, figs. 11a, b; Tong, 1978, p. 218, pl. 78, figs. 17a-c; Yang and Gao, 1996, pl. 34, figs. 7-8.
Urushtenoidea chenanensis (Chan). Jin and Hu, 1978, p. 117, pl. 2, fig. 9; Hu, 1983, pl. 3, figs. 4-5.
Urushtenoidea maceus (Ching). Nakamura, 1979, p. 227, pl. 1, figs. 1-4; pl. 2, figs. 1-3; Minato *et al.*, 1979, pl. 65, figs. 8-11.
Urushtenoidea crenulata (Ting). Nakamura, 1979, p. 228, pl. 1, figs. 5-9; pl. 3, figs. 1-2; Tazawa, 2000, figs. 3.10, 3.11.
Uncisteges crenulata (Ting). Liu *et al.*, 1982, p. 178, pl. 129, figs. 1a-d; Jin, 1985, pl. 6, fig. 41; Zhu, 1990, p. 74, pl. 14, figs. 4-14; pl. 17, figs. 12, 12a.

Material.—Fifteen specimens, from locality HMF2; (1) external mould of a ventral valve and associated internal mould of conjoined valve, NU-B405; (2) internal mould of a conjoined valve, NU-B406; (3) internal moulds of six ventral valves, NU-B407-412; (4) external and internal moulds of a dorsal valve, NU-B413; (5) external moulds of three dorsal valves, NU-B414-416; (6) internal moulds of three dorsal valves, NU-B417-419.

Description.—Shell medium size for genus, transversely subquadrate in outline; hinge straight, a little less than greatest width; the latter occurring at about midvalve; length 12 mm, width 19 mm in a smaller ventral valve specimen (NU-B406); length 12 mm, width 20 mm in a larger dorsal valve specimen (NU-B415).

Ventral valve strongly geniculated at right angle and followed by long trail; umbo small; lateral slopes steep; ears small; sulcus low and wide, originating at midvisceral disc. External ornament of ventral valve consisting of few weak concentric rugae and costae on visceral disc, numerous costae on trail; costae regular, straight and strong on trail, with a density of 6 per 5 mm at middle of trail; anterior half of ventral trail having some concentric rugae and row of spines on costae. Dorsal valve almost flat on visceral disc, strongly geniculated, and followed by short trail; fold low and wide. External ornament of brachial valve similar to that of opposite valve, but more distinct and regular reticulate ornament on visceral disc.

Interior of dorsal valve with a median septum, extending to midvalve, a pair of elongate muscle scars on both sides of median septum. Other internal structures not observed in the present specimens.

Remarks.—These specimens are identical with *Urushtenoidea crenulata* (Ting, in Yang *et al.*, 1962) in size, shape

and external ornament of shell, especially the density of costae on the ventral trail. *Urushtenoidea chenanensis* (Chan, in Chan and Lee, 1962) is a synonym of the present species.

Urushtenoidea maceus (Jin, 1963), originally described and figured as *Urushtenia maceus* from the Middle Permian of Hubei, Anhui, Zhejiang and Jiangsu, south China (Jin, 1963, p. 19, pl. 2, figs. 1–6) somewhat resembles *U. crenulata* in size and outline, but the former differs from the latter in having much finer costae on the ventral valve.

Distribution. — Middle Permian (Murgabian-Midian) of Cambodia (Sisophon), south China (Guizhou, Sichuan, Hunan, Guangdong, Jiangxi, Fujian, Jiangsu, Hubei and Shaanxi), northwest China (Qinghai and Gansu), and Japan (South Kitakami and Hida Gaien Belts).

Superfamily Lyttonioidea Waagen, 1883
Family Lyttoniidae Waagen, 1883
Subfamily Lyttoniinae Waagen, 1883
Genus ***Leptodus*** Kayser, 1883

Type species.—*Leptodus richthofeni* Kayser, 1883.

Leptodus nobilis (Waagen, 1883)

Figure 7.13–7.16

Lyttonia nobilis Waagen, 1883, p. 398, pl. 29, figs. 1–3; pl. 30, figs. 1, 2, 5, 6, 8, 10, 11; Diener,1897, p. 37, pl. 1, figs. 5–7; Noetling, 1904, p. 112, text-figs. 4–7; Noetling, 1905, p. 140, pl. 17, figs. 1, 2; pl. 18, figs. 1–11, text-fig. 2; Mansuy, 1913, p. 123, pl. 13, fig. 10; Mansuy, 1914, p. 32, pl. 6, figs. 7a–d; pl. 7, figs. 1a–e; Diener, 1915, p. 99, pl. 10, fig. 15; Albrecht, 1924, p. 289, figs. 1a, b; Grabau, 1931, p. 285, pl. 28, figs. 3–6; Huang, 1932, p. 89, pl. 7, figs. 9, 10; pl. 8, figs. 8, 9; pl. 9, figs. 1–8, text-figs. 8–11; Simic, 1933, p. 49, pl. 4, fig. 1.

Lyttonia tenuis Waagen, 1883, p. 401, pl. 30, figs. 3, 4, 7, 9.

Lyttonia sp. Yabe, 1900, p. 2, text-figs. 1, 2.

Lyttonia cf. *tenuis* Waagen. Mansuy, 1912, p. 19, pl. 4, fig. 4; pl. 5, figs. 1a–e; Huang, 1936, p. 493, pl. 1, fig. 6.

Oldhamina (*Lyttonia*) *richthofeni* var. *nobilis* Waagen. Fredericks, 1916, p. 76, pl. 4, fig. 2, text-fig. 22.

Lyttonia richthofeni (Kayser). Hayasaka, 1917, p. 43, pl. 18, figs. 1–8; Hayasaka, 1922a, p. 62, pl. 11, figs. 1–6; Hayasaka, 1922b, p. 103, pl. 4, figs. 12, 13; Fredericks, 1925, p. 14, pl. 3, figs. 105–107; Licharew, 1932, p. 56, 86, pl. 1, figs. 1–16; pl. 2, figs. 1, 2, 5, 7, 10, 12; pl. 3, figs. 2–7; pl. 4, figs. 1–17; pl. 5, figs. 1–4, 6; Mashiko, 1934, p. 182, text-fig.

Lyttonia (*Leptodus*) *richthofeni* Kayser. Hamlet, 1928, p. 31, pl. 6, figs. 1–4.

Lyttonia richthofeni forma *nobilis* Waagen. Licharew, 1932, p. 69, 96, pl. 2, figs. 13, 14; pl. 5, figs. 1–4, 6; text-fig. 3.

Lyttonia cf. *richthofeni* (Kayser). Huang, 1932, p. 87, pl. 8, figs. 4a, b.

Leptodus nobilis (Waagen). Wanner and Sieverts, 1935, p. 249, pl. 9, figs. 27, 28; text-figs. 16–18; Termier and Termier, 1960, p. 241, text-pl. 3, figs. 1–10; Chi-Thuan, 1961, p. 274, pl. 1, figs. 1a, b; Schréter, 1963, p. 107, pl. 3, figs. 5–8; Sarytcheva, 1964, p. 65, pl. 7, figs. 5–8; text-fig. 1; Ruzhentsev and Sarytcheva, 1965, pl. 39, figs. 6–8; Cooper and Grant, 1974, pl. 191, figs. 8, 9; Grant, 1976, pl. 43, figs. 18, 19; Lee and Gu, 1976, p. 267, pl. 162, figs. 1, 2; Tazawa, 1976, pl. 2, fig. 8; Yang *et al.*, 1977, p. 371, pl. 147, fig. 5; Feng and Jiang, 1978, p. 269, pl. 100, fig. 2; Licharew and Kotlyar, 1978, pl. 14, figs. 13–15; Jin *et al.*, 1979, p. 82, pl. 23, fig. 15; Minato *et al.*, 1979, pl. 66, figs. 1, 4, 5; Zhan, 1979, p. 93, pl. 9, fig. 12; Lee *et al.*, 1980, p. 389, pl. 172, figs. 15, 16; Wang *et al.*, 1982, p. 229, pl. 95, fig. 20; Zhan and Wu, 1982, pl. 4, fig. 4; Ding and Qi, 1983, p. 297, pl. 102, figs. 7, 8; Yang, 1984, p. 226, pl. 35, fig. 12; Gu and Zhu, 1985, pl. 1, figs. 31, 33, 34; Liao and Meng, 1986, p. 81, pl. 2, figs. 24, 25; Sremac, 1986, p. 30, pl. 10, figs. 1-2; Tazawa, 1987, fig. 1.11; Kotlyar, in Kotlyar and Zakharov, 1989, pl. 20, fig. 6; pl. 23, fig. 12; Liang, 1990, p. 225, pl. 40, figs. 1, 5; Tazawa and Matsumoto, 1998, p. 7, pl. 2, figs. 7–12; Tazawa *et al.*, 1998, p. 241, figs. 2.1, 2.2; Kato *et al.*, 1999, p. 47, figs. 4a, b; Tazawa, 2000, figs. 3.14, 3.15, 7.1a, 7.1b; Tazawa and Ibaraki, 2001, p. 11, pl. 1, figs. 7–10.

Lyttonia cf. *nobilis* Waagen. Huang, 1936, p. 493, pl. 1, fig. 5.

Leptodus cf. *nobilis* (Waagen). Thomas, 1957, p. 177, pl. 20, figs. 1–6.

Leptodus richthofeni Kayser. Shimizu, 1961, pl. 18, figs. 14, 15; Schréter, 1963, p. 106, pl. 3, fig. 4; Sarytcheva, 1964, p. 65, pl. 7, figs. 2–4; Yang *et al.*, 1977, p. 372, pl. 147, fig. 10; Yang, 1984, p. 226, pl. 35, fig. 11; Duan and Li, 1985, p. 119, pl. 35, figs. 17–19.

Leptodus ivanovi Frederiks. Minato *et al.*, 1979, pl. 66, fig. 3.

Leptodus sp. Minato *et al.*, 1979, pl. 66, fig. 2.

Leptodus tenuis (Waagen). Yang, 1984, p. 226, pl. 35, fig. 13; Duan and Li, 1985, p. 119, pl. 35, figs. 14–16; Liang, 1990, p. 226, pl. 40, fig. 9; Zhu, 1990, p. 79, pl. 18, figs. 19–21.

Leptodus sp. Tazawa, 1987, fig. 1.10.

Gubleria sp. Zhu, 1990, p. 80, pl. 16, fig. 24.

Material.—Nine specimens, from locality HMF2: (1) external and internal moulds of three ventral valves, NU-B420–422; (2) external mould of a ventral valve, NU-B423; (3) internal moulds of five ventral valves, NU-B424–428.

Description.—Shell small to medium size for genus, elongate subtrigonal in outline, with greatest width near anterior margin; length 40 mm, width 32 mm in the largest specimen (NU-B424). Ventral valve almost flat, slightly convex in lateral and anterior profiles. Ventral valve interior with regularly and synmmetrically arranged lateral septa on both sides of mediam septum; lateral septa broad and solid (solidiseptate), straight to slightly arched toward front, numbering 12 pairs in the largest specimen; interseptal spaces 2.0–2.5 mm in width; median septum highly developed.

Remarks.—These specimens are relatively small in size, and seem to be immature shells of *Leptodus nobilis* (Waagen, 1883), originally described by Waagen (1883, p. 398) from the Wargal and Chhidru Formations of the Salt Range. The Moribu specimens externally most resemble the shells, described as *Lyttonia richthofeni* (Kayser) by Hayasaka (1917, p. 43, pl. 18, figs. 1–6; Hayasaka, 1922a, p. 62, pl. 11, figs. 2, 3) from the lower Kanokura Formation of the southern Kitakami Mountains.

The type species, *Leptodus richthofeni* Kayser, 1883 from the Permian of Loping, Jiangxi Province, south China (Kayser, 1883, p. 161, pl. 21,figs.9–11; Cooper and Grant, 1974, p. 411, pl. 191, figs. 11–15) differs from *L. nobilis* in having a more strongly convex ventral valve, with sharp lat-

eral septa and much broader interseptal spaces.

Distribution.—Middle Permian (Kubergandian) to Upper Permian (Dorashamian) of Hungary, Croatia, Serbia, western Russia (Caucasus Mountains), Pakistan (Salt Range and Khisor Range), India (Kashmir), Nepal (Kumaon Himalayas), Cambodia, Laos, Timor, northern Australia (Port Keats), northwest China (Tibet and Qinghai), south China (Yunnan, Guangxi, Guizhou, Sichuan, Hubei, Hunan, Guangdong, Jiangxi, Fujian and Zhejiang), north China (Inner Mongolia), northeast China (Jilin and Heilongjiang), eastern Russia (South Primorye), and Japan (Imo, Kamiyasse, Matsukawa and Ogatsu in the South Kitakami Belt, Moribu and Ise in the Hida Gaien Belt, Takauchi in the Maizuru Belt and Akasaka in the Mino Belt).

Order Orthotetida Waagen, 1884
Suborder Orthotetidina Waagen, 1884
Superfamily Orthotetoidea Wagen, 1884
Family Derbyiidae Stehli, 1954
Genus ***Derbyia*** Waagen, 1884

Type species.—*Derbyia regularis* Waagen, 1884.

Derbyia sp.

Figure 7.11

Derbyia sp. Tazawa, 2000, fig. 3.2.

Material.—One specimen, from locality HMF2, internal mould of a ventral valve, NU-B429.

Remarks.—This specimen is safely assigned to the genus *Derbyia* by its almost flat ventral valve, ornamented by numerous fine costellae and having a strong median septum 10 mm long. However, the single imperfect specimen does not allow specific assignment.

Order Orthida Schuchert and Cooper, 1932
Suborder Dalmanellidina Moore, 1952
Superfamily Enteletoidea Waagen, 1884
Family Enteletidae Waagen, 1884
Genus ***Enteletes*** Fischer de Waldheim, 1825

Type species.—*Enteletes glabra* Fischer de Waldheim, 1830.

Enteletes sp.

Figure 7.10a, 7.10b

Enteletes sp. Tazawa, 2000, figs. 3.1a, 3.1b.

Material.—One specimen, from locality HMF1, internal mould of a ventral valve, NU-B430.

Remarks.—The single ventral valve specimen of Moribu is safely assigned to the genus *Enteletes* by its small size (length about 10 mm, width about 11 mm), rounded elliptical outline, and having a long median septum and a pair of thin, long, subparallel dental plates, both of them extending to the midvalve. Specific identification remains difficult due to the poor preservation of the specimen.

Order Rhynchonellida Kuhn, 1949
Superfamily Stenoscismatoidea Oehlert, 1887
Family Stenoscismatidae Oehlert, 1887
Genus ***Stenoscisma*** Conrad, 1839

Type species.—*Terebratula schlotheimii* von Buch, 1835.

Stenoscisma margaritovi (Tschernyschew, 1888)

Figure 8.1a–8.4

Camarophoria margaritovi Tschernyschew, 1888, p. 355, figs. 1–3; Fredericks, 1924, p. 48, pl. 1, figs. 32–42; text-fig. 4.

Camarophoria humbletonensis Howse. Hayasaka, 1922a, p. 62, pl. 9, figs. 10–12; pl. 10, fig. 9; Hayasaka, 1966, p. 1226, text-figs. 6–8.

Stenoscisma humbletonensis (Howse). Tazawa, 1976, pl. 2, figs. 9, 10; Minato *et al.*, 1979, pl. 66, figs. 6–8.

Stenoscisma gigantea (Diener). Lee and Gu, 1976, p. 272, pl. 176, fig. 3; pl. 177, fig. 18; Lee *et al.*, 1980, p. 395, pl. 173, figs. 6, 8.

Stenoscisma margaritovi (Tschernyschew). Licharew and Kotlyar, 1978, pl. 17, figs.7a, b; Koczyrkevicz, 1979b, p. 50, pl. 11, figs. 5, 6; Duan and Li, 1985, p. 120, pl. 43, figs. 5–8; Tazawa and Matsumoto, 1998, p. 9, pl. 2, figs. 1–5; Tazawa, 2000, fig. 3.5; Tazawa, Takizawa and Kamada, 2000, p. 10, pl. 1, figs. 7–11.

Stenoscisma gigantea elongatum Lee and Su, in Lee *et al.*, 1980, p. 395, pl. 173, figs. 1, 2.

Stenoscisma purdoni (Davidson). Lee *et al.*, 1980, p. 395, pl. 173, figs. 4, 5, 7.

Material.—Five specimens, from localities HMF2, 3: (1) external cast of a conjoined valve, NU-B431; (2) external casts of three ventral valves, NU-B432–434; (3) external cast of a dorsal valve, NU-B435.

Description.—Shell medium size for genus, longer than wide, with greatest width slightly anterior to midvalve; length 21 mm, width about 18 mm in the best preserved specimen (NU-B434). Ventral valve gently convex in lateral profile; umbo small; sulcus shallow; costae often bifurcating or intercalating anteriorly, numbering 7-9 on sulcus and 6–7 on each flank. Dorsal valve moderately convex in lateral profile, with low fold; costae numbering 8 on fold and 6–7 on each flank.

Remarks.—These specimens are poorly preserved but can be referred to *Stenoscisma margaritovi* (Tschernyschew, 1888) by their narrow and elongate outline, shallow ventral sulcus and low dorsal fold, and rather numerous costae on both valves.

The shells, described and figured as *Stenoscisma humbletonensis* (Howse, 1848) from the lower Kanokura Formation of the southern Kitakami Mountains (Hayasaka, 1922a, 1966; Tazawa, 1976; Minato *et al.*, 1979), are referred to *S. margaritovi* on the basis of their shallow sulcus, low fold, and many costae on both valves.

An elongate species, described as *Stenoscisma gigantea* (Diener, 1897), *S. gigantea elongatum* Lee and Su, in Lee *et al.*, 1980, and *S. purdoni* (Davidson, 1862) from the Middle Permian of Jilin and Heilongjiang, northeast China and Jisu (Zhesi), Inner Mongolia (Lee and Gu, 1976; Lee *et al.*, 1980), may be conspecific with *S. margaritovi* .

Stenoscisma tetricum Grant (1976, p. 185, pl. 50, figs. 9-28) from the Rat Buri Limestone of Ko Muk, southern Thailand is also close to *S. margaritovi* in size and outline, but the Thailand species is distinguished from the present species by its strong concentric laminae on both valves.

Distribution. — Middle Permian (Murgabian-Midian) of north China (Inner Mongolia), northeast China (Heilongjiang and Jilin), eastern Russia (South Primorye), and Japan (South Kitakami and Hida Gaien Belts).

Superfmily Rhynchoporoidea Muir-Wood, 1955
Family Rhynchoporidae Muir-Wood, 1955
Genus ***Rhynchopora*** King, 1865

Type species. — *Terebratula geinitziana* de Verneuil, in Murchison *et al.*, 1845.

Rhynchopora sp.

Figure 8.5a-8.5c

Rhynchopora sp. Shi and Tazawa, 2001, p. 756, figs. 2.2a, b.

Material.—One specimen, from locality HMF1, internal mould of a conjoined valve, NU-B478.

Remarks.—This specimen is safely assigned to the genus *Rhynchopora* by its small size (length 10 mm, width 9 mm), pentagonal outline, fine simple costae and, in particular, the high dorsal fold which originates from midvalve, has 5 costae and is sharply incurved ventrally to form almost a square-shaped, flat anterior surface at the anterior margin. The Moribu specimen well resembles *Rhynchopora tchernyshae* Koczyrkevicz (1979a, p. 47, pl. 11, figs. 1-4), originally described from the lower Barabash Formation of South Primorye, in size and outline of the shell, and the number of costae on the dorsal fold. But accurate comparison is difficult for the poorly preserved specimen.

Order Athyridida Boucot, Johnson and Staton, 1964
Suborder Retziidina Boucot, Johnson and Staton, 1964
Superfmily Retzioidea Waagen, 1883
Family Neoretziidae Dagis, 1972
Subfamily Hustediinae Grunt, 1986
Genus ***Hustedia*** Hall and Clarke, 1893

Type species.—*Terebratula mormonii* Marcou, 1858.

Hustedia ratburiensis Waterhouse and Piyasin, 1970

Figure 8.6a-8.6c

Hustedia ratburiensis Waterhouse and Piyasin, 1970, p. 138, pl. 23, figs. 15-30; Grant, 1976, p. 241, pl. 66, figs. 1-69; pl. 67, figs. 51-58; Sun, 1991, p. 254, pl. 6, figs. 5-8; Yanagida and Nakornsri, 1999, p. 118, pl. 32, figs.11-16.

Hustedia thailandica Waterhouse and Piyasin, 1970, text-figs. 12, 13.

Hustedia nakornsrii Yanagida, 1970, p. 79, pl. 14, figs. 9a-d.

Material.—Four specimens, from localities HMF1, 2, 5: (1) external moulds of two ventral valves, NU-B436, 437; (2) external mould of a dorsal valve, NU-B438; (3) internal mould of a dorsal valve, NU-B439.

Description.—Shell small to medium for genus, suboval in outline, with greatest width slightly anterior to midvalve; length 9 mm, width 8 mm in the larger ventral valve specimen (NU-B436). Ventral valve moderately convex in both lateral and anterior profiles, without sulcus. External surface of ventral valve ornamented by simple, broad and rounded costae; 2 close-set costae medially and 3 pairs of costae laterally. Dorsal valve moderately convex in both profiles, having no fold, and ornamented by 3 costae medially and 3 pairs of costae laterally; costae originating at umbo except median costa, which commences a little below umbo; outer 2 pairs of costae curved towards posterolateral margins. Internal structure of dorsal valve obscure in the present material.

Remarks.—The Moribu specimens can be referred to *Hustedia ratburiensis* Waterhouse and Piyasin, 1970 by their external ornament, 2 close-set costae on median part of the ventral valve and 3 costae on median part of the dorsal valve, especially the median costa of the dorsal valve originating a short distance below umbo. This species was described and compared in detail by Waterhouse and Piyasin (1970), Yanagida (1970) and Grant (1976).

A single dorsal valve specimen, figured by Koizumi (1979, pl. 1, fig. 5) as *Hustedia indica* (Waagen, 1883) from the Kashiwadaira Formation of the Takakurayama area, Abukuma Mountains, northeast Japan, resembles closely *H. ratburiensis* in having a median costa originating slightly anterior to umbo.

Distribution. — Lower Permian (Artinskian) to Upper Permian (Dzhulfian) of north-central Thailand (Khao Hin King), southern Thailand (Khao Phrik, Khao Tok Nam and Ko Muk), and central Japan (Hida Gaien Belt).

Order Spiriferida Waagen, 1883
Suborder Spiriferidina Waagen, 1883
Superfamily Martinioidea Waagen, 1883
Family Martiniidae Waagen, 1883
Subfamily Martiniinae Waagen, 1883
Genus ***Martinia*** M'Coy, 1844

Type species.—*Spirifer glaber* Sowerby, 1820.

Martinia sp.

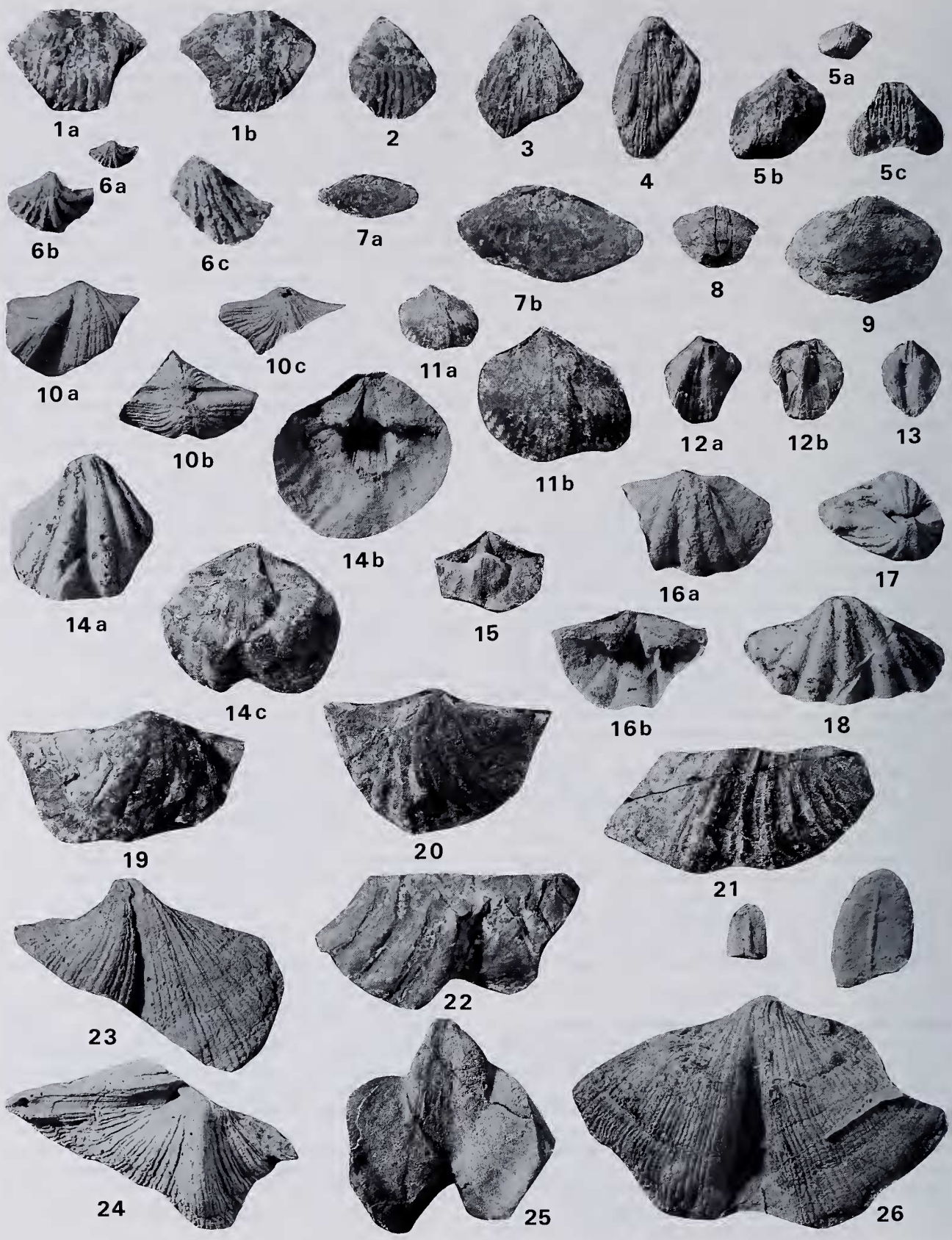
Figure 8.7a, 8.7b

Material.—One specimen, from locality HMF3, internal mould of a ventral valve, NU-B440.

Remarks.—This specimen is safely assigned to the genus *Martinia* by its transversely subelliptical ventral valve with several vascular markings radially branching out from umbonal region and extending two-thirds of the length of the valve. However, the poor preservation of this specimen prevents accurate specific identification.

Family Martiniopsidae Kotlyar and Popeko, 1967
Genus ***Martiniopsis*** Waagen, 1883

Type species.—*Martiniopsis inflata* Waagen, 1883.


1a
1b
2
3
4
5a
5b
5c
6a
6b
6c
7a
7b
8
9
10a
10b
10c
11a
11b
12a
12b
13
14a
14b
14c
15
16a
16b
17
18
19
20
21
22
23
24
25
26

Martiniopsis sp.

Figure 8.8, 8.9

Material.—Two specimens, from locality HMF1, internal moulds of two ventral valves, NU-B441, 442.

Remarks.—These specimens are fragmentarily preserved, but safely assigned to the genus *Martiniopsis* by their transversely oval outline and a pair of long adminicula reaching to the midlength of the ventral valves. The Moribu species is a medium, transverse *Martiniopsis*; length about 21 mm, width about 28 mm in the lager specimen (NU-B441), and most resembles *Martiniopsis cathaysiensis* Grabau (1936, p. 242, pl. 21, figs. 7, 8; pl. 24, figs. 9a-e), from the Maping Limestone of Guangxi and Guizhou, south China, in size and shape of the ventral valve.

The single ventral valve specimen, described as *M. cathaysiensis* by Hayasaka (1967, p. 254, figs. 2a, b) from the lower Kanokura Formation of the southern Kitakami Mountains, is poorly preserved, and inadequate for comparison.

Superfamily Spiriferoidea King, 1846
Family Trigonotretidae Schuchert, 1893
Subfamily Neospiriferinae Waterhouse, 1968
Genus ***Neospirifer*** Fredericks, 1919

Type species.—*Spirifer fasciger* Keyserling, 1846.

Neospirifer cf. ***fasciger*** (Keyserling, 1846)

Figure 8.10a-8.10c

Compare.—
Spirifer fasciger Keyserling, 1846 pars, p. 231, pl. 8, fig. 3b only; Chao, 1925, p. 236, pl. 3, figs. 1-2.
Spirifer (*Neospirifer*) *fasciger* Keyserling. Ozaki, 1931, p. 28, pl. 1, figs. 3-6.
Neospirifer fasciger (Keyserling). Archbold and Thomas, 1984 pars, figs. 1F, H, I, 2C only; Poletaev, 1997, pl. 4, figs. 2-7.

Material.—One specimen, from locality HMF8, external mould of a conjoined valve, NU-B443.

Remarks.—The material available is a single imperfect shell lacking the anterior and lateral parts. This specimen is safely assigned to the genus *Neospirifer* because of its distinct fasciculate costae on the lateral slopes of both valves. Externally the Moribu specimen most resembles the shells of *Neospirifer fasciger* (Keyserling, 1846), described from the Upper Carboniferous of Gansu and Shanxi, north China and Jilin and Liaoning, northeast China (Chao, 1925; Ozaki, 1931). The lectotype of *N. fasciger*, designated by Cooper and Grant (1976, p. 2173) and refigured by Archbold and Thomas (1984, figs. 1F-I, 2C) and Poletaev (1997, pl. 4, figs. 3b-3d) is also close to the present specimen in size, outline and ornament of the brachial valve. The present material is, however, too imperfect for comparison.

Genus ***Blasispirifer*** Kulikov, 1950

Type species.—*Spirifer blasii* de Verneuil, 1845.

Blasispirifer cf. ***reedi***
(Licharew, in Licharew and Kotlyar, 1978)

Figure 8.11a-8.13

Spirifer cf. *reedi* Licharew. Shi and Tazawa, 2001, p. 756, figs. 2.4-6.

Material.— Three specimens, from localities HMF1, 3: (1) internal mould of a conjoined valve, NU-B479; (2) internal mould of a ventral valve, NU-B480; (3) internal mould of a dorsal valve, NU-B481.

Description.—Shell small for genus, slightly transverse, rounded rhomboidal in outline, with narrow hinge; length 13 mm, width 14 mm in a dorsal valve specimen (NU-B481). Ventral valve with a narrow and deep sulcus. Dorsal valve having a narrow but distinct fold; costae mostly simple, but weakly bundled in the innermost pair bounding fold; numbering 9-12 on each slope, 5-6 on fold in dorsal valve. Internally ventral valve lacking dental plates. Dorsal valve with no crural plates.

Remarks.—These specimens are safely assigned to the genus *Blasispirifer* by their small, rounded rhomboidal shell, fine, weakly bundled costae on dorsal valve, and lacking both dental plates and crural plates. In size and shape, the Moribu specimens most resemble *Blasispirifer reedi*

← **Figure 8.** **1a-4.** *Stenoscisma marganitovi* (Tschernyschew), 1a, 1b: Ventral and dorsal views of external cast of a conjoined valve, NU-B431, 2: External cast of a ventral valve, NU-B434, 3: External cast of a ventral valve, NU-B433, 4: External cast of a ventral valve, NU-B432, **5a-5c.** *Rhynchopora* sp., dorsal and anterior views of internal mould of a conjoined valve, NU-B478, (5b, 5c ×2), 6a-**6c.** *Hustedia ratburiensis* Waterhouse and Piyasin, 6a, 6b: External latex cast of a dorsal valve, NU-B438, (6b ×2), 6c: External cast of a ventral valve, NU-B436, (×2), **7a, 7b.** *Martinia* sp., internal mould of a ventral valve, NU-B440, (7b ×2), **8, 9.** *Martiniopsis* sp., internal moulds of two ventral valves, NU-B442, 441, **10a-10c.** *Neospirifer* cf. *fasciger* (Keyserling), ventral, posterior and dorsal views of external latex cast of a conjoined valve, NU-B443, **11a-13.** *Blasispirifer* cf. *reedi* (Licharew), 11a, 11b: Internal mould of a dorsal valve, NU-B481, (11b ×2), 12a, 12b: Ventral and dorsal views of internal mould of a conjoined valve, NU-B479, 13: Internal mould of a ventral valve, NU-B480, **14a-14c.** *Alispiriferella ordinaria* (Einor), external and internal latex casts and internal mould of a ventral valve, NU-B458, **15-18.** *Alispiriferella japonica* sp. nov., 15: Internal mould of a ventral valve, NU-B462, 16a, 16b: External and internal latex casts of a ventral valve, NU-B461 (holotype), 17: Posterior view of external latex cast of a conjoined valve, NU-B460, 18: External latex cast of a ventral valve, NU-B465, **19-22.** *Spiriferella lita* (Fredericks), 19: External cast of a dorsal valve, NU-B455, 20: External cast of a dorsal valve, NU-B452, 21: External cast of a dorsal valve, NU-B456, 22: External cast of a ventral valve, NU-B451, **23-26.** *Gypospirifer volatilis* Duan and Li, 23. External latex cast of a ventral valve, NU-B444, 24: External latex cast of a dorsal valve, NU-B449, 25: Internal mould of a ventral valve, NU-B448, 26: External latex cast of a ventral valve, NU-B445, **27, 28.** *Dielasma* sp., external latex casts of two ventral valves, NU-B475, 474. (Natural size unless otherwise indicated).

(Licharew, 1978), originally described by Licharew (in Licharew and Kotlyar, 1978, p. 73, pl. 21, figs. 13a, b, v) from the Chandalaz Formation of South Primorye. Accurate comparison is difficult due to the lack of clear external information in the present material.

Genus ***Gypospirifer*** Cooper and Grant, 1976

Type species.—*Gypospirifer nelsoni* Cooper and Grant, 1976.

Gypospirifer volatilis Duan and Li, 1985

Figure 8.23-8.26

Gypospirifer volatilis Duan and Li, 1985, p. 127, 207, pl. 48, figs. 1-2; pl. 49, figs. 1-2.
Gypospirifer sp. Tazawa, 2000, figs. 3.12, 3.13.

Material.—Seven specimens, from localities HMF5, 12, 25: (1) external moulds of a conjoined valve, NU-B444; (2) external moulds of three ventral valves, NU-B445-447; (3) internal mould of a ventral valve, NU-B448; (4) external and internal moulds of a dorsal valve, NU-B449; (5) external mould of a dorsal valve, NU-B450.

Description.—Shell medium to large for genus, transversely semielliptical in outline, with greatest width at hinge, and slightly alate; length 42 mm, width about 73 mm in the best preserved specimen (NU-B445).

Ventral valve gently convex in lateral and anterior profiles, most convex at umbonal region; umbo slightly extended and strongly incurved; sulcus very deep and rapidly widening anteriorly, with U-shaped bottom. External surface of ventral valve ornamented by numerous fine costae and concentric ornament of some rugae and numerous fine growth lines; costae subridged, added by bifurcation, and weakly fasciculated, numbering 9-10 in 10 mm at about midvalve, 7-8 in 10 mm at anterior margin. Dorsal valve gently convex in both profiles, having a high and narrow fold. External ornament of dorsal valve identical to opposite valve.

Ventral interior with a pair of thick, short dental plates and a deeply impressed, large, heart-shaped muscle field. Other internal structures not preserved.

Remarks.—These specimens are referred to *Gypospirifer volatilis* Duan and Li, 1985, originally described from the Middle Permian Zhesi (Jisu) Formation of the Zhesi area, Inner Mongolia, by their size, outline and surface ornament of shells, especially the deep ventral sulcus and high dorsal fold.

Gypospirifer marcoui (Waagen, 1883, p. 510, pl. 47, figs. 1-3) from the Amb and Wargal Formations of the Salt Range most resembles *G. volatilis*, but differs from the latter in having a shallower ventral sulcus and a lower dorsal fold.

The type species, *G. nelsoni* Cooper and Grant (1976, p. 2214, pl. 591, figs. 8-9) from the Hueco Formation of west Texas is clearly distinguished from *G. volatilis* by its more transverse shell, shallower ventral sulcus and lower dorsal fold.

Distribution.—Middle Permian (Murgabian) of north China (Inner Mongolia) and central Japan (Hida Gaien Belt).

Family Spiriferellidae Waterhouse, 1968
Subfamily Spiriferellinae Waterhouse, 1968
Genus ***Spiriferella*** Tschernyschew, 1902

Type species.—*Spirifer saranae* de Verneuil, 1845.

Spiriferella lita (Fredericks, 1924)

Figure 8.19-8.22

Spirifer saranae mut. *lita* Fredericks, 1924, p. 36, pl. 1, figs. 16-27; Hayasaka, 1925, p. 98, pl. 5, fig. 14.
Spiriferella lita (Fredericks). Tazawa, 1979, p. 28, pl. 4, figs. 12-13; pl. 5, figs. 1-4, 6; Tazawa, 2000, fig. 3.9.

Material.—Seven specimens, from locality HMF2: (1) external cast of a ventral valve, NU-B451; (2) external mould and casts of three dorsal valves, NU-B452-454; (3) external casts of three dorsal valves, NU-B455-457.

Description.—Shell medium size for genus, transversely trapezoidal in outline; cardinal extremities blunt, produced; hinge straight, equal to widest part; length about 40 mm, width 68 mm+ in a dorsal valve specimen (NU-B457); length about 27 mm, width 43 mm in the best preserved dorsal valve specimen (NU-B452). Ventral valve having a deep, wide, V-shaped and smooth-bottomed sulcus and 5 strong, simple costae on each side of sulcus. Dorsal valve moderately convex in both lateral and anterior profiles, with a high fold and 5-6 simple or slightly bifurcated costae on each side of fold; fold having a median groove.

Remarks.—*Spiriferella lita* (Fredericks, 1924), originally described from the Middle Permian of Ussuri, South Primorye, is characterized by its strong and simple costae on the ventral valve, especially the enormously large costae on both sides of the sulcus. The material available consists of a fragmentarily preserved ventral valve and six incomplete dorsal valves. These specimens can be assigned to *S. lita* on account of their large, transverse shells with strong and simple costae on the ventral valve.

Spiriferella keilhavii (von Buch, 1846), from the Middle Permian of Bear Island, is also a large, transverse *Spiriferella*, but it differs from *S. lita* by its weakly fasciculate costae on both valves.

Distribution.—Middle Permian (Murgabian-Midian) of eastern Russia (South Primorye) and Japan (South Kitakami and Hida Gaien Belts).

Genus ***Alispiriferella*** Waterhouse and Waddington, 1982

Type species.—*Spiriferella ordinaria* Einor, 1939.

Alispiriferella ordinaria
(Einor, in Licharew and Einor, 1939)

Figure 8.14a-8.14c

Spirifer (*Spiriferella*) *keilhavi* var. *ordinaria* Einor, in Licharew and Einor, 1939, p. 140, pl. 23, figs. 6, 7; pl. 24, figs. 1a-d.
Spiriferella ordinaria Einor. Nelson and Johnson, 1968, p. 738, pl. 95, figs. 5, 6; pl. 96, figs. 4-6; text-figs. 10, 13a; Bamber and Waterhouse, 1971, pl. 15, figs. 10, 12-14; Waterhouse *et al.*, 1978, pl. 2, figs. 6-8.

Alispiriferella ordinaria (Einor). Waterhouse and Waddington, 1982, p. 30, pl. 2, figs. 7–13; text-figs. 11i, j, 20; Abramov and Grigorjeva, 1988, p. 158, pl. 22, figs. 7a-g; pl. 25, figs. 4, 5; Shi and Waterhouse, 1996, p. 133, pl. 25, figs. 11–15; text-fig. 46.

Material.—Two specimens, from locality HMF12: (1) external and internal moulds of a ventral valve, NU-B458; (2) external mould of a dorsal valve with internal moulds of a conjoined valve, NU-B459.

Description.—Shell small to medium for genus, slightly wider than long, subpentagonal in outline, with greatest width at hinge; length about 31 mm, width about 37 mm in the better preserved specimen (NU-B458).

Ventral valve moderately convex in lateral profile, most convex at posterior third of shell length; cardinal extremities blunt, produced; interarea moderately high, triangular in shape and slightly concave; sulcus deep and having smooth, broad, V-shaped bottom; 4 pairs of broad, rounded, simple or bifurcated costae on ventral valve. Dorsal valve having a low fold, with a deep, wide, flat-bottomed median groove for almost entire length; 4 pairs of bifurcated or trifurcated costae on dorsal valve.

Ventral valve interior with a pair of high dental plates and a deeply impressed heart-shaped muscle field. Other internal structures not observed in the present material.

Remarks.—The Moribu specimens are not so well preserved but they can be identified with *Alispiriferella ordinaria* (Einor, 1939) by their small, slightly wider subpentagonal shell, with weakly bundled costae on both ventral and dorsal valves. This species was originally described by Einor (in Licharew and Einor, 1939) from the Lower Permian of Novaya Zemlya, and afterwards redescribed by Waterhouse and Waddington (1982) as the type species of the genus *Alispiriferella*.

Distribution.—Lower Permian (Asselian) to Middle Permian (Murgabian) of the Arctic Russia (Novaya Zemlya, western Verkhoyansk Range), northern Canada (Yukon Territory) and central Japan (Hida Gaien Belt).

Alispiriferella japonica sp. nov.

Figure 8.15–8.18

Spiriferella sp. Horikoshi *et al.*, 1987, p. 142; Tazawa, 1987, text-figs. 1.1, 1.3.
Alispiriferella sp. Tazawa, 2000, fig. 3.8.

Material.—Fourteen specimens, from localities HMF1, 2, 5, 8, 14, 16: (1) external mould of a conjoined valve, NU-B460; (2) external and internal moulds of three ventral valves, NU-B461 (holotype), 462, 463; (3) external moulds of eight ventral valves, NU-B464-471; (4) internal moulds of two dorsal valves, NU-B472, 473.

Diagnosis.—Small, transversely much wider *Alispiriferella* with alate cardinal extremities, smooth ventral sulcus and coarse, simple and rounded costae on both valves.

Description.—Shell small for genus, alate, transversely subquadrate in outline, with greatest width at hinge; length 21 mm, width 39 mm in the largest specimen (NU-B465); length 18 mm, width about 32 mm in the holotype (NU-B461).

Ventral valve strongly convex in lateral profile, most convex at umbonal region; umbo well extended and strongly incurved; interarea moderately high, nearly triangular in shape; cardinal extremities slightly produced; sulcus deep and wide, having smooth, rounded bottom; costae broad and simple with rounded crest, numbering 4–5 on each flank of ventral valve. Dorsal valve moderately convex in lateral profile; fold originating at beak and having a narrow but distinct median groove, which extends from umbo to anterior margin; each flank having 3–4 coarse, simple and rounded costae.

Ventral valve interior with high dental plates and a deeply impressed heart-shaped muscle field; the latter is longitudinally striated and divided into two parts by a low ridge with a median narrow groove. Dorsal valve interior obscure in the present material.

Remarks.—*Alispiriferella japonica* sp. nov. is distinguished from *Alispiriferella ordinaria* (Einor, 1939) by its more alate and wider outline, smooth noncostate ventral sulcus and coarse, simple costae on both valves.

The present species somewhat resembles *Alispiriferella* sp. Yanagida (1996, figs. 2.2, 2.4) from the Middle Permian Tsunemori Formation of Akiyoshi, southwest Japan in having transverse shell, broad, simple costae on both valves, and dorsal fold with a narrow median groove. The Akiyoshi species is unfortunately represented by only two incomplete specimens, and an accurate comparison is therefore hampered.

Alispiriferella gydalensis (Zavodowsky, 1968, p. 159, pl. 46, fig. 1) from the Middle Permian Omolon Horizon (correlated with the Kungurian) of the Kolyma River region, northeastern Siberia, differs from *A. japonica* in having a much larger shell and dorsal fold with a wide, shallow median groove.

Order Terebratulida Waagen, 1883
Suborder Terebratulidina Waagen, 1883
Superfamily Dielasmatoidea Schuchert, 1913
Family Dielasmatidae Schuchert, 1913
Subfamily Dielasmatinae Schuchert, 1913
Genus ***Dielasma*** King, 1859

Type species.—*Terebratulites elongatus* Schlotheim, 1816.

Dielasma sp.

Figure 8.27, 8.28

Material.—Two specimens, from locality HMF3, external moulds of two ventral valves, NU-B474, 475.

Description.—Shell medium size for genus, elongate subpentagonal in outline, almost flat to slightly concave in both lateral and anterior profiles; length 29 mm, width 15 mm in the larger specimen (NU-B474). Ventral valve with narrow but distinct median fold, originating slightly anterior to umbo and extending to anterior margin. External surface of ventral valve smooth.

Remarks.—This species may be a new species of *Dielasma*. The Moribu species resembles *Dielasma* sp. B, described by Yang *et al.* (1962, p. 118, pl. 46, figs. 8a–c)

from the Middle (?) Permian of Qilianshan Mountains, Qinghai, northwest China, in size and shape of the ventral valve and in having a narrow, distinct median fold on the ventral valve.

Dielasma biplex Waagen (1882, p. 349, pl. 25, figs. 3–5) from the Wargal Formation of the Salt Range also has a narrow median ventral fold, but it is clearly distinguished from the Moribu species by its strongly convex ventral valve.

Acknowledgements

I would like to thank Guang R. Shi of Deakin University, Melbourne for critical reading of the manuscript; Katsuyoshi Tsushima of Utsunomiya City for help in the field survey; Ei Horikoshi of Toyama City and Yukio Miyake of Miya-mura, Gifu Prefecture for providing a part of the brachiopod specimens.

References

Abramov, B. S. and Grigoreva, A. D., 1988: *Biostratigrafiya i brakhiopody permi Verkhoyanya*, 204 p., 32 pls., Nauka, Moskva. (*in Russian*)

Albrecht, J., 1924: Paläontologische und stratigraphische Ergebnisse der Forschungsreise nach Westserbien 1918. *Akademie der Wissenschaften in Wien, Mathematisch-Naturwissenschaftliche Klasse, Denkschriften*, vol. 99, p. 289–307, 1 pl.

Archbold, N. W., 1993: Studies on western Australian Permian brachiopods 11. New genera, species and records. *Proceedings of the Royal Society of Victoria*, vol. 105, no. 1, p. 1-29.

Archbold, N. W. and Bird, P. R., 1989: Permian Brachiopoda from near Kasliu Village, west Timor. *Alcheringa*, vol. 13, p. 103–123.

Archbold, N. W. and Thomas, G. A., 1984: *Neospirifer* Fredericks, 1924 (Spiriferida, Brachiopoda): A review. *Journal of Paleontology*, vol. 58, no. 3, p. 626–635.

Bamber, E.W. and Waterhouse, J.B., 1971: Carboniferous and Permian stratigraphy and paleontology, northern Yukon Territory, Canada. *Bulletin of Canadian Petroleum Geology*, vol. 19, no. 1, p. 29-250, pls. 1–27.

Boucot, A. J., Johnson, J. G. and Staton, R. D., 1964: On some atrypoid, retzioid and athyridoid Brachiopoda. *Journal of Paleontology*, vol. 38, no. 5, p. 805–822, pls. 125–128.

Bronn, H. G., 1862: *Die Klassen und Ordnungen der Weichthiere (Malacozoa), vol. 3, no. 1*, 518 p., 44 pls., C.F. Winter'sche Verlagshandlung, Leipzig u. Heidelberg.

Buch, L. von, 1835: Ueber Terebrateln. *Abhandlungen der Königlichen Akademie der Wissenschaften in Berlin, 1833*, p. 21–144, pls. 1–3.

Buch, L. von, 1846: Über *Spirifer keilhavii*, über dessen Fundort und Verhältniss zu ähnlichen Formen. *Abhandlungen der Königlichen Akademie der Wissenschaften in Berlin, 1846*, p. 65–80.

Chan (Zhan), L. and Lee, L., 1962: Early Permian Maokouan brachiopods from eastern Qinling. *Acta Palaeontologia Sinica*, vol. 10, no. 4, p. 472–493, pls. 1–4. (*in Chinese*)

Chao, Y. T., 1925: On the age of the Taiyuan Series of North China. *Bulletin of the Geological Society of China*, vol. 4, p. 221–249, pls. 1–3.

Chao, Y. T., 1927: Productidae of China, pt. 1. Producti. *Palaeontologia Sinica, Ser. B*, vol. 5, fasc. 2, p. 1–244, pls. 1–16.

Chi-Thuan, T. T., 1961: Les brachiopodes permiens du Phnom-Tup (Sisophon-Cambodge). *Annales de la Faculté des Sciences, Université de Saigon, 1961*, p. 267–308, pls. 1–8.

Chi-Thuan, T. T., 1962: Les brachiopodes permiens de Cam-Lo (Province de Quang-Tri). *Annales de la Faculté des Sciences, Université de Saigon, 1962*, p. 485-498, pls. 1, 2.

Colani, M. M., 1919: Sur quelques fossiles ouralo-permiens de Hongay. *Bulletin du Service Géologique de l'Indochine*, vol. 6, fasc. 5, p. 1–27, pls. 1, 2.

Coleman, P.J., 1957: Permian Productacea of western Australia. *Bulletin, Bureau of Mineral Resources, Geology and Geophysics*, no. 40, p. 1–189, pls. 1–21.

Conrad, T. A., 1839: Descriptions of new species of organic remains. *New York State Geological Survey, Annual Report*, vol. 3, p. 57–66.

Cooper, G. A. and Grant, R. E., 1974: Permian brachiopods of west Texas, 2. *Smithsonian Contributions to Paleobiology*, no. 15, p. 233–793, pls. 24–191.

Cooper, G. A. and Grant, R. E., 1976: Permian brachiopods of west Texas, 4. *Smithsonian Contributions to Paleobiology*, no. 21, p. 1923–2607, pls. 503–662.

Czarnieski, S., 1969: Sedimentary environment and stratigraphical position of the Treskelodden Beds (Vestspitsbergen). *Prace Muzeum Ziemi*, no. 16, p. 201–336, pls. 1–16.

Dagis, A. S., 1972: Morfolgiya i systema mezozoyskikh rettsioidnykh brakhiopod; Voprosy morfologii, sistemy i filogenii v paleontologii. *Trudy Institut Geologii i Geofiziki*, vol. 112, p. 94-105. (*in Russian*).

Davidson, T., 1848: Sur les brachiopodes du système silurien supérieur de l'Angletere. *Société Géologique de France, Bulletin, Ser. 2*, vol. 5, p. 309–338, 370–374.

Davidson, T., 1862: On some Carboniferous Brachiopoda, collected in India by A. Fleming, M.D., and W. Purdon, Esq., F.G.S. *Quarterly Journal of the Geological Society of London*, vol. 18, p. 25–35, pls. 1, 2.

Diener, C., 1897: The Permocarboniferous fauna of Chitichun, no. 1. *Palaeontologia Indica, Ser. 15*, vol. 1, pt. 3, p. 1–105, pls. 1–13.

Diener, C., 1903: Permian fossils of the central Himalayas. *Palaeontologia Indica, Ser. 15*, vol. 1, pt. 5, p. 1–204, pls. 1–10.

Diener, C., 1915: The Anthracolithic faunae of Kashmir, Kanaur and Spiti. *Palaeontologia Indica, N. S.*, vol. 5, no. 2, p. 1–135, pls. 1–11.

Ding, P. and Qi, W., 1983: Carboniferous and Permian Brachiopoda. *In*, Xian Institute of Geology and Mineral Resources *ed.*, *Palaeontological Atlas of Northwest China; Shaanxi, Gansu and Ninxia Volume, pt. 2. Upper Palaeozoic*, p. 244–425, pls. 88–139, Geological Publishing House, Beijing. (*in Chinese*)

Duan, C. and Li, W., 1985: Description of fossils, (4) Phylum Brachiopoda. *In*, Ding, Y., Xia, G., Duan, C., Li, W., Liu, X. and Liang, Z., Study on the Early Permian Stratigraphy and Fauna in Zhesi District, Nei Mongol Zizhiqu (Inner Mongolia). *Bulletin of the Tianjin Institute of Geology and Mineral Resources*, no. 10, p. 99–145, 199–214, pls. 32–55. (*in Chinese*)

Fan, B. and He, X., 1999: *Research on brachiopod fauna and stratigraphy of the Late Paleozoic in North China Platform*. 179 p., 40 pls., China University of Mining and Technology Press, Xuzhou. (*in Chinese*)

Feng, R. and Jiang, Z., 1978: Phylum Brachiopoda. *In*, Geological and Palaeontological Team of Guizhou *ed.*, *Palaeontological Atlas of Southwest China; Guizhou, pt. 2. Carboniferous to Quaternary Volume*, p. 231-305, pls. 85 - 108, Geological Publishing House, Beijing. (*in Chinese*)

Fischer de Waldheim, G., 1825: *Notice sur la Choristite*, 12 p., 1 pl., Moscow.

Fischer de Waldheim, G., 1830: *Oryctographie du Gouvernment de Moscou, [1st edition]*, 26 p., 60 pls., Moscow.

Fredericks, G., 1916: Paleontologicheskiya Zametki, 2. O nekotorykh verkhne-paleozoyskikh brakhiopodakh Evrazii. *Trudy Geologicheskago Komiteta, N. S.*, vol. 156, p. 1-87, pls. 1-5. (*in Russian*)

Fredericks, G., 1919: O verkhne-kamennougolnykh spiriferidakh Urala. *Izvestiia Geologicheskogo Komiteta*, vol. 38, no. 3, p. 295-324. (*in Russian*)

Fredericks, G., 1924: Ussuriyskiy verkhniy paleozoy, 1. Brachiopoda. *Materiali po geologii i poleznim iskopaemim Dalnego Vostoka*, no. 28, p. 1-52, pl. 1. (*in Russian*)

Fredericks, G., 1925: Ussuriyskiy verkhniy paleozoy, 2. Permskie brakhiopodi s misa Kaluzina. *Materiali po geologii i poleznim iskopaemim Dalnego Vostoka*, no. 40, p. 1-28, pls. 1-4. (*in Russian*)

Fredericks, G., 1928: Material dlya klassifikatsii roda *Productus* Sow. *Izvestiia Geologicheskogo Komiteta*, vol. 46, no. 7, p. 773-792. (*in Russian*)

Fujimoto, H., Kanuma, M. and Igo, H., 1962: On the Upper Paleozoic of the Hida Massif. *In*, Fujimoto, H. *ed.*, *Geological Studies of the Hida Massif*, p. 44 - 70, Geological Research Group of the Hida Massif, Tokyo. (*in Japanese*)

Gobbett, D. J., 1963: Carboniferous and Permian brachiopods of Svalbard. *Norsk Polarinstitutt Skrifter*, no. 127, p. 1-201, pls. 1-25.

Grabau, A. W., 1931: The Permian of Mongolia. *In*, Reeds, C. A. *ed.*, *Natural history of Central Asia, vol. 4*, 665 p., 35 pls., American Museum of Natural History, New York.

Grabau, A. W., 1936: Early Permian fossils of China, pt. 2. Fauna of the Maping Limestone of Kwangsi and Kweichou. *Palaeontologia Sinica, Ser. B*, fasc. 4, p. 1-441, pls. 1-31.

Grant, R. E., 1976: Permian brachiopods from southern Thailand. *Paleontological Society Memoir*, 9, p. 1-269, pls. 1-71.

Gray, J. E., 1840: *Synopsis of the contents of the British Museum, 42nd edit.*, 370 p., London.

Grigoreva, A. D., Ganelin, V. G. and Kotlyar, G. V., 1977: Systematicheskoe opisanie: Semeystvo Linoproductidae. *In*, Sarytcheva, T. G. *ed.*, Pozdnepaleozoyskie produktidy Sibiri i Arktiki. *Trudy Paleontologicheskogo Instituta*, vol. 161, p. 126-165, pls. 19-27. (*in Russian*)

Grunt, T. A., 1986: Sistema brakhiopod otryada Atirídida. *Trudy Paleontologicheskogo Instituta*, vol. 215, p. 1-200, pls. 1-32. (*in Russian*)

Gu, F. and Zhu, R., 1985: Lower Permian brachiopods from Lin-Dong, Nei Mongol. *Bulletin of the Shenyang Institute of Geology and Mineral Resources*, no. 12, p. 74-97, pls. 1-4. (*in Chinese*)

Hall, J. and Clarke, J. M., 1893: An introduction to the study of the genera of Palaeozoic Brachiopoda. *New York Geological Survey*, vol. 8, pt. 2, p. 1-317, pls. 21-84.

Hamlet, B., 1928: Permische Brachiopoden, Lamellibranchiaten und Gastropoden von Timor. *Jaarboek van het Mijnwezen in Nederlandsche-Indië, Verhandelingen, 1927*, vol. 2, p. 1-115, pls. 1-12.

Hayasaka, I., 1917: On the brachiopod genus *Lyttonia* with several Japanese and Chinese examples. *Journal of the Geological Society of Tokyo*, vol. 24, no. 288, p. 43-53, pl. 18.

Hayasaka, I., 1922a: Some Permian brachiopods from the Kitakami Mountains. *Japanese Journal of Geology and Geography*, vol. 1, no. 2, p. 51-70, pls. 9-11.

Hayasaka, I., 1922b: Paleozoic Brachiopoda from Japan, Korea and China, pt. 1. Middle and Southern China. *Science Reports of the Tohoku Imperial University, 2nd Ser.*, vol. 6, no. 1, p. 1-116, pls. 1-5.

Hayasaka, I., 1925: On some brachiopods from the *Lyttonia* horizon of the Kitakami Mountains. *Japanese Journal of Geology and Geography*, vol. 4, nos. 3, 4, p. 89-103, pl. 5.

Hayasaka, I., 1960: On the occurrence of *Neospirifer fasciger* (Keyserling) in Japan, and a note on some associate Permian brachiopods from around Kesen-numa City, northeast Japan. *Collection of Essays in Commemoration of the Tenth Anniversary (1959) of Shimane University, Natural Science*, p. 34-57, pls. 1-3.

Hayasaka, I., 1963: Some Permian fossils from southern Kitakami, 2. Two brachiopods species. *Proceedings of the Japan Academy*, vol. 39, no. 7, p. 479-483.

Hayasaka, I., 1966: Some Permian fossils from southern Kitakami, 6. Three brachiopods. *Proceedings of the Japan Academy*, vol. 42, no. 10, p. 1223-1228.

Hayasaka, I., 1967: Some Permian fossils from southern Kitakami, 10. Two smooth-shelled spiriferids: *Martinia* and *Martiniopsis*. *Proceedings of the Japan Academy*, vol. 43, no. 6, p. 522-525.

Hayasaka, I. and Minato, M., 1956: Some brachiopods from the lower Kanokura Series of the Kitakami Mountains, Japan. *Transactions and Proceedings of the Palaeontological Society of Japan, N. S.*, no. 21, p. 141-147, pl. 23.

Horikoshi, E., Tazawa, J., Naito, N. and Kaneda, J., 1987: Permian brachiopods from Moribu, north of Takayama City, Hida Mountains, central Japan. *Journal of the Geological Society of Japan*, vol. 93, no. 2, p. 141-143. (*in Japanese*)

Howse, R., 1848: A catalogue of the fossils of the Permian System of the counties of Northumberland and Durham. *Tyneside Naturalists' Field Club, Transactions*, vol. 1, p. 219-264.

Hu, S., 1983: Brachiopods from the Hsiaochiangpien Limestone, southern Jiangxi. *Acta Palaeontologica Sinica*, vol. 22, no. 3, p. 338-345, pls. 1-3. (*in Chinese*)

Huang, T. K., 1932: Late Permian Brachiopoda of southwestern China, pt. 1. Productidae and Lyttonidae. *Palaeontologia Sinica, Ser. B*, vol. 9, fasc. 1, p. 1-107, pls. 1-9.

Huang, T. K., 1933: Late Permian Brachiopoda of southwestern China, pt. 2. *Palaeontologia Sinica, Ser. B*, vol. 9, fasc. 2, p. 1-131, pls. 1-11.

Huang, T. K., 1936: On the occurrence of *Lyttonia* in the Wolfcamp Series of the Glass Mountains of Texas with notes on lyttonids from southwestern China. *Bulletin of the Geological Society of China*, vol. 15, no. 1, p. 489–493, pl. 1.

Ifanova, V. V., 1972: Permskie brakhiopodi Pechorskogo basseyna. *In*, Ifanova, V.V. and Semenova, E.G., *Srednekamennougolnye i permskie brakhiopody vostoka i severa evropeyskoy chasti SSSR*, p. 72–161, pls. 1–13, Nauka, Moskva. (*in Russian*)

Isomi, H. and Nozawa, T., 1957: *Explanation text of the geological map of Japan, scale 1:50,000, "Funatsu"*, 43 p., Geological Survey of Japan, Kawasaki. (*in Japanese*)

Ivanov, A. P., 1935: Fauna brakhiopod srednego i verkhnego karbona Podmoskovnogo Basseyna. *Trudy Moskovskogo Geologicheskogo Tresta*, fasc. 8, p. 1–163, pls. 1–15. (*in Russian*)

Jin, Y., 1963: *Urushtenia* from the Lower Permian of China. *Acta Palaeontologia Sinica*, vol. 11, no. 1, p. 1–31, pls. 1, 2. (*in Chinese*)

Jin, Y., 1985: Permian Brachiopoda and paleogeography of the Qinghai-Xizang (Tibet) Plateau. *Palaeontologia Cathayana*, no. 2, p. 19–71, pls. 1–8.

Jin, Y. and Hu, S., 1978: Brachiopods of the Kuhfeng Formation in south Anhui and Nanking Hills. *Acta Palaeontologia Sinica*, vol. 11, no. 2, p. 101–127, pls. 1–4. (*in Chinese*)

Jin, Y., Liao, Z. and Fang, B., 1974: Permian Brachiopoda. *In*, Nanjing Institute of Geology and Palaeontology *ed.*, *Handbook of Stratigraphy and Palaeontology of Southwest China*, p. 308–311, pls. 162–165, Science Press, Beijing. (*in Chinese*)

Jin, Y., Ye, S., Yu, H. and Sun, D., 1979: Phylum Brachiopoda. *In*, Nanjing Institute of Geology and Palaeontology and Qinghai Institute of Geological Sciences *eds.*, *Palaeontological Atlas of Northwest China; Qinghai, pt. 1*, p. 60–217, pls. 18–57, Geological Publishing House, Beijing. (*in Chinese*)

Kalashnikov, N. V., 1980: *Brakhiopody verkhnego paleozoya Evropeyskogo Severa SSSR*, 132 p., 39 pls., Nauka Leningrad. (*in Russian*)

Kalashnikov, N. V., 1983: Brakhiopody. *In*, Meyen, S. V. *ed.*, *Paleontologicheskiy atlas permskikh otlozheniy Pechorskogo ugolnogo basseyna*, p. 203–221, pls. 45–59, Nauka, Leningrad. (*in Russian*)

Kalashnikov, N. V., 1993: *Brakhiopody permi Evropeyskogo Severa Rossii*, 113 p., 36 pls., Nauka, Sankt-Peterburg. (*in Russian*)

Kato, M., Takeuchi, K., Hendarsyah, A. and Sundari, D., 1999: On the occurrence of the Permian brachiopod genus *Leptodus* in Timor. *Geological Research and Development Centre, Bandung, Paleontology Series*, no. 9, p. 43–51.

Kayser, E., 1883: Obercarbonische Fauna von Lo-Ping. *In*, Richthofen, F. von *ed.*, *China, Vierten Band*, p. 160–208, pls. 19–29, Dietrich Reimer, Berlin.

Keyserling, A., 1846: Geognostische Beobachtungen. *In*, Krusenstern, P. von and Keyserling, A. *eds.*, *Wissenschaftliche Beobachtungen auf einer Reise in das Petschora-Land im Jahre 1843*, p. 151–406, Carl Kray, St. Petersburg.

King, R. E., 1931: The geology of the Glass Mountains, Texas, pt. 2: Faunal summary and correlation of the Permian formations with descriptions of Brachiopoda. *University of Texas Bulletin*, 3042, p. 1–245, pls. 1–44.

King, W., 1846: Remarks on certain genera belonging to the class Palliobranchiata. *Annals and Magazine of Natural History, Ser. 1*, vol. 18, p. 26–42, 83–94.

King, W., 1859: On *Gwynia*, *Dielasma* and *Macandrevia*, three new genera, etc. *Dublin Zoological and Botanical Association, Proceedings*, vol. 1, pt. 3, p. 256–262.

King, W., 1865: Remarks of the history of two species of *Rhynchopora geinitziana* de Verneuil, from near the River Oukhla, Province of Archangel. *Annals and Magazine of Natural History, Ser. 3*, vol.16, p. 124–128.

Koczyrkevicz, B. V., 1979a: Novie permskie *Rhynchopora* (Brachiopoda) Yuzhnogo Primorya i nekotorie voprosi ikh morfologii. *In*, Petrashevskaya, V. T. *ed.*, *Iskopaemie bespozvonochnie Dalnego Vostoka*, p. 41–49, pls. 10, 11, DVNTS AN SSSR, Vladivostok. (*in Russian*)

Koczyrkevicz, B. V., 1979b: Permskie stenostsizmatatsem (Brachiopoda) Yuzhnogo Primorya. *In*, Petrashevskaya, V. T. *ed.*, *Iskopaemie bespozvonochnie Dalnego Vostoka*, p. 50-59, pls. 11–13, DVNTS AN SSSR, Vladivostok. (*in Russian*)

Koizumi, H., 1979: Permian brachiopods from Takakura-yama Formation and its geological age, N.E. Japan. *Bulletin of the Taira Chigaku Dokokai, Spec. vol.*, p.1–3, pl. 1. (*in Japanese*)

Kotlyar, G. V., 1961: Rod *Yakovlevia* Fredericks. *Dokladi, Akademii Nauk SSSR*, vol. 140, no. 2, p. 459–461. (*in Russian*)

Kotlyar, G. V. and Popeko, L. I., 1967: *Biostratigrafiya, mshanki i brakhiopody verkhnego paleozoya Zabaykalya*, 324 p., 57 pls., Zabaykalskogo Filiala Geograficheskogo Obschestva SSSR, Chita. (*in Russian*)

Kotlyar, G. V. and Zakharov, Yu. D., 1989: *Pozdnepermskiy etap evolyutsii organicheskogo mira; Midiyskiy yarus SSSR*, 182 p., 28 pls., Nauka, Leningrad. (*in Russian*)

Kuhn, O., 1949: *Lehrbuch der Paläozoologie*, 326 p., E. Schweizerbart, Stuttgart.

Kulikov, M. V., 1950: O sistematike spiriferov iz verkhnepermskikh otlozheny Evropeyskoy chasti SSSR. *Trudy VSEGEI*, vol. 1, p. 3–7. (*in Russian*)

Lazarev, S. S., 1982: O nekotorykh brakhiopod semeystva Buxtoniidae. *Paleontologicheskiy Zhurnal, 1982*, no. 1, p. 65-72, pl. 8. (*in Russian*)

Lazarev, S. S., 1986: *Osnovnye napravleniia evoliutsii i sistema brakhiopod podotriada Productidina*, 41 p., Avtoreferat dissertatsii na soiskanie ushenoi stepeni Doktora Biologicheskikh Nauk, Akademia Nauk SSSR, Paleontologicheskii Institut, Moskva. (*in Russian*)

Lee, L. and Gu, F., 1976: Carboniferous and Permian Brachiopoda. *In*, Geological Bureau of Nei Mongol and Geological Institute of Northeast China *eds.*, *Palaeontological Atlas of Northeast China; Nei Mongol, pt. 1. Palaeozoic Volume*, p. 228–306, pls. 131–184, Geological Publishing House, Beijing. (in Chinese)

Lee, L., Gu, F. and Li, W., 1982: A new genus and some new species of brachiopod from Lower Permian of Xi Ujimqin Qi, Nei Mongol. *Bulletin of the Shenyang Institute of Geology and Mineral Resources, Chinese Academy of Geological Sciences*, no. 4, p. 113–129, pls. 1, 2. (*in Chinese*)

Lee, L., Gu, F. and Su, Y., 1980: Carboniferous and Permian Brachiopoda. *In*, Shenyang Institute of Geology and

Mineral Resources *ed.*, *Palaeontological Atlas of Northeast China, pt. 1. Palaeozoic Volume*, p. 327–428, pls. 145–180, Geological Publishing House, Beijing. (*in Chinese*)

Liang, W., 1990: Lengwu Formation of Permian and its brachiopod fauna in Zhejiang Province. *Geological Memoirs, Ministry of Geology and Mineral Resources, Ser. 2*, no. 10, p. 1–522, pls. 1–84. (*in Chinese*)

Liao, Z. and Meng, F., 1986: Late Chanxsingian brachiopods from Huatang of Chen Xian County, southern Hunan. *Memoirs of Nanjing Institute of Geology and Palaeontology*, no. 22, p. 71–94, pls. 1–5. (*in Chinese*)

Licharew, B. K., 1932: Fauna permskikh otlozheniy Severnogo Kavkaza, 2. Brachiopoda. Sem. Lyttoniidae Waagen. *Trudy VSEGEI*, vol. 215, p. 55–111, pls. 1–5. (*in Russian*)

Licharew, B. K. and Einor, O. L., 1939: Materialy k poznaniyu verkhnepaleozoyskikh faun Novoy Zemli Brachiopoda. *Trudy Arkticheskogo Nauchno-Issledovatelskogo Instituta*, vol. 127, p. 1–245, pls. 1–28. (*in Russian*)

Licharew, B. K. and Kotlyar, G. V., 1978: Permskie brakhiopody Yuzhnogo Primorya. *In*, Popeko, L. I. *ed.*, *Verkhniy paleozoy Severo-vostochnoy Azii*, p. 63-75, pls. 11–22, DVNTS AN SSSR, Vladivostok. (*in Russian*)

Liu, F. and Waterhouse, J. B., 1985: Permian strata and brachiopods from Xiujimqinqi region of Neimongol (Inner Mongolia) Autonomous region, China. *Papers, Department of Geology, University of Queensland*, vol. 11, no. 2, p. 1–44, pls. 1–12.

Liu, Z., Tan, Z. and Ding, Y., 1982: Phylum Brachiopoda. *In*, Geological Bureau of Hunan *ed.*, *The Palaeontological atlas of Hunan*, p. 172–216, pls. 125–159, Geological Publishing House, Beijing. (*in Chinese*)

Manankov, I. N., 1998: Verkhnepermskie produktidy (brakhiopody) Yugo-Vostochnoy Mongolii. *Paleontologicheskiy Zhurnal, 1998*, no. 5, p. 49–55, pl. 8. (*in Russian*)

Mansuy, H., 1912: Mission du Laos. *Mémoires du Service Géologique de l'Indochine*, vol. 1, fasc. 4, p. 1–52, pls. 1–13.

Mansuy, H., 1913: Faunes des calcaires a Productus de l'Indochine, Première série. *Mémoires du Service Géologique de l'Indochine*, vol. 2, fasc. 4, p. 1–133, pls. 1–13.

Mansuy, H., 1914: Faunes des calcaires a productus de l'Indochine, Deuxième série. *Mémoires du Service Géologique de l'Indochine*, vol. 3, fasc. 3, p. 1–59, pls. 1–7.

Marcou, J., 1858: *Geology of North America, with two reports on the prairies of Arkansas and Texas, the Rocky Mountains of New Mexico and the Sierra Nevada of California*, 144 p., Zürich.

Mashiko, K., 1934: Discovery of *Lyttonia* in a limestone exposed at Takauti, Nakayakuno-mura, Amata-gun, Kyoto Prefecture. *Japanese Journal of Geology and Geography*, vol. 11, nos. 3, 4, p. 181–183

M'Coy, F., 1844: *A synopsis of the characters of the Carboniferous limestone fossils of Ireland*, 207 p., 29 pls., Dublin.

Miloradovich, B. V., 1935: Materialy k izucheniyu verkhnepaleozoyskikh brakhiopod severnogo ostrova Novoy Zemli. *Trudy Arkticheskogo Instituta*. vol. 19, p. 1–168, pls. 1–6. (*in Russian*)

Minato, M., 1943: Notes on some Permian fossils from the Toman Formation in southeastern Manchoukuo. *Journal of the Faculty of Science, Hokkaido Imperial University, Ser. 4*, vol. 7, no. 1, p. 49–58, pls. 5, 6.

Minato, M., Hunahashi, M., Watanabe, J. and Kato, M., 1979: *Variscan geohistory of northern Japan: The Abean Orogeny*, 427 p., 92 pls., Tokai University Press, Tokyo.

Moore, R. C., 1952: Brachiopoda. *In*, Moore, R.C., Lalicker, C. G. and Fischer, A. G., *Invertebrate fossils*, p. 197–267, McGraw-Hill, New York.

Muir-Wood, H. M., 1955: *A history of the classification of the phylum Brachiopoda*, 124 p., British Museum (Natural History), London.

Muir-Wood, H. M., 1962: *On the morphology and classification of the brachiopod suborder Chonetoidea*, 132 p., 16 pls., British Museum (Natural History), London.

Muir-Wood, H. M. and Cooper, G.A., 1960: Morphology, classification and life habits of the Productoidea (Brachiopoda). *Geological Society of America, Memoir*, 81, p. 1–447, pls. 1–135.

Murchison, R. I., Verneuil, É. de and Keyserling, A. de, 1845: *Géologie de la Russie d'Europe et des Montagnes de l'Oural, vol. 2. Paléontologie*, 395 p., 43 pls., John Murray, London and Bertrand, Paris.

Nakamura, K., 1959: Some Lower Permian Sakamotozawa brachiopods. *Journal of the Faculty of Science, Hokkaido University, Ser. 4*, vol. 10, no. 1, p. 199–207, pls. 1, 2.

Nakamura, K., 1972: *Anidanthus* and *Megousia* (Brachiopoda) from the Permian of Japan and Cambodia. *Journal of the Faculty of Science, Hokkaido University, Ser. 4*, vol. 15, nos. 3, 4, p. 427–445, pls. 1, 2.

Nakamura, K., 1979: Additional occurrences of *Urushtenoidea* (Brachiopoda) from the Permian of Asia. *Journal of the Faculty of Science, Hokkaido University, Ser. 4*, vol. 19, nos. 1, 2, p. 221–233, pls. 1–3.

Nakamura, K., Kato, M. and Choi, D. R., 1970: On *Permundaria*, a new genus of the brachiopod family Linoproductidae. *Journal of the Faculty of Science, Hokkaido University, Ser. 4*, vol. 14, no. 3, p. 293–299, pl. 2.

Nelson, S. J. and Johnson, C. E., 1968: Permo-Pennsylvanian brachythyrid and horridonid brachiopods from the Yukon Territory, Canada. *Journal of Paleontology*, vol. 42, no. 3, p. 715–746, pls. 90–96.

Noetling, F., 1904: Über den Bau und die Organisation der Lyttoniidae Waagen. *Verhandlungen der Deutschen Zoologischen Gesellschaft, 1904*, p. 103–122.

Noetling, F., 1905: Untersuchungen über die Familie Lyttoniidae Waagen emend. Noetling. *Palaeontographica*, vol. 51, p. 129–154, pls. 15–18.

Oehlert, D. P., 1887: *Manuel de conchyliologie et de paléontologie conchyliologique, ou Histoire naturelle des mollusques vivants et fossiles, pt. 11*, p. 1189–1334, Savy, Paris.

Orbigny, A. d', 1842: *Voyages dans l'Amérique méridionale*, p. 50–56, pls. 3–5, Pitois-Levrault et cie, Paris.

Orbigny, A. d', 1847: Considérations zoologiques et géologiques sur les brachiopodes ou palliobranches. *Comptes Rendus de la Academie des Sciencies Paris*, vol. 25, p. 193–195, 266–269.

Ozaki, K., 1931: Upper Carboniferous brachiopods from north China. *Bulletin of the Shanghai Science Institute*, vol. 1, no. 6, p. 1–205, pls. 1–15.

Pecar, J., 1986: Upper Carboniferous and Permian mesolobid

chonetacean brachiopods of Karavanke Mountains (Yugoslavia) and Carnic Alps (Italy). *Geologija*, vols. 28, 29, p. 9–53, pl. 1.

Poletaev, V. I., 1997: Reviziya roda *Neospirifer* Fredericks, 1924; novyy rod podsemeystva Neospiriferinae-*Lutuginia*. *Paleontologicheskiy Zhurnal, 1997*, no. 3, p. 54–63, pl. 4. (*in Russian*)

Prendergast, K. L., 1935: Some western Australian Upper Palaeozoic fossils. *Journal of the Royal Society of Western Australia*, vol. 21, p. 9–35, pls. 2–4.

Prendergast, K. L., 1943: Permian Productinae and Strophalosiinae of western Australia. *Journal of the Royal Society of Western Australia*, vol. 28, p. 1–73, pls. 1–6.

Ramovs, A., 1958: Razvoj zgornjega perma v Loskih in Polhograjskih hribih. *Razprave Slovenska Akademija Znanosti in Umetnosti*, vol. 4, p. 455–622, pls. 1–10.

Reed, F. R. C., 1944: Brachiopoda and Mollusca from the Productus Limestones of the Salt Range. *Palaeontologia Indica, N. S.*, vol. 23, no. 2, p. 1–678, pls. 1–65.

Rothpletz, A., 1892: Die Perm-, Trias- und Jura-Formation auf Timor und Rotti im indischen Archipel. *Palaeontographica*, vol. 39, p. 57–106, pls. 9–14.

Ruzhentsev, V. E. and Sarytcheva, T. G., 1965: Razvitie i smena morskikh organizmov na rubezhe Paleozoya i Mesozoya. *Trudy Paleontologicheskogo Institute*, vol. 108, p. 1–431, pls. 1–58. (*in Russian*)

Sarytcheva, T. G., 1964: Oldgaminoidnie brakhiopodi iz permi Zakavkazya. *Paleontologicheskiy Zhurnal, 1964*, no. 3, p. 58–72, pls. 7, 8. (*in Russian*)

Sarytcheva, T. G. and Sokolskaya, A. N., 1952: Opredelitel paleozoyskikh brakhiopod Podmoskovnoy Kotloviny. *Trudy Paleontologicheskogo Instituta*, vol. 38, p. 1–300, pls. 1–71. (*in Russian*)

Sarytcheva, T. G. and Sokolskaya, A. N., 1959: O klassifikatsii lozhnoporidtykh brakhiopod. *Doklady Akademia Nauk SSSR*, vol. 125, no. 1, p.181–184. (*in Russian*)

Schellwien, E., 1898: Die Auffindung einer permo-carbonischen Fauna in den Ostalpen. *Geologische Reichsanstalt Verhandlungen (Vienna), 1898*, no. 16, p. 358–363.

Schlotheim, E. F. von, 1816: Beiträge zur Naturgeschichte der Versteinerungen in geognostischer Hinsicht. *Denkschriften der Wissenschaften in München, Mathematisch- Physikalische Klasse*, vol. 6, p. 13–36.

Schréter, Z., 1963: A Bükkhegység felsö-permi brachiopodai. *Geologica Hungarica, Series Palaeontologica*, fasc. 28, p. 1–181, pls. 1–9.

Schuchert, C., 1893: Classification of the Brachiopoda. *American Geologist*, vol. 11, p. 141–167, pl. 5.

Schuchert, C., 1913: Class 2. Brachiopoda. *In*, Zittel, A. von ed., *Text-book of Palaeontology, vol. 1, pt. 1, 2nd* ed., p. 355-420, MacMillion, London.

Schuchert, C., 1929: Classification of brachiopod genera, fossil and recent. *In*, Schuchert, C. and LeVene, C. M., Animalia pars 42, *Fossilium Catalogus, vol. 1*, p. 10–25, Junk, Berlin.

Schuchert, C. and Cooper, G. A., 1932: Brachiopod genera of the suborders Orthoidea and Pentameroidea. *Memoirs of the Peabody Museum of Natural History*, vol. 4, pt. 1, p. 1–270, pls. 1–29.

Shi, G. R. and Tazawa, J., 2001: *Rhynchopora* and *Blasispirifer* (Brachiopoda) from the Middle Permian of the Hida Gaien Belt, central Japan, and their paleobiogeographical significance. *Journal of the Geological Society of Japan*, vol. 107, no. 12, p. 755–761.

Shi, G. R. and Waterhouse, J. B., 1996: Lower Permian brachiopods and mollusks from the upper Jungle Creek Formation, northern Yukon Territory, Canada. *Geological Survey of Canada, Bulletin*, 424, p.1–241, pls. 1–32.

Shimizu, D., 1961: Brachiopod fossils from the Permian Maizuru Group. *Memoirs of the College of Science, University of Kyoto, Ser. B*, vol. 27, no. 3, p. 309-350, pls. 15–18.

Simic, V., 1933: Gornji Perm u Zapadnoj Srbiji. *Mémoires du Service Géologique du Royaume de Yougoslavie*, vol. 1, p. 1–130, pls. 1-9.

Sowerby, J., 1818–1821: *The mineral conchology of Great Britain, vol. 3*, p. 1–184, pls. 204–306, London.

Sremac, J., 1986: Middle Permian brachiopods from the Velebit Mts. (Croatia, Yugoslavia). *Palaeontologia Jugoslavica*, vol. 35, p. 1–43, pls. 1–15.

Stehli, F. G., 1954: Lower Leonardian Brachiopoda of the Sierra Diablo. *Bulletin of the American Museum of Natural History*, vol. 105, art. 3, p. 262–358, pls. 17–27.

Sun, D., 1991: Permian (Sakmarian-Artinskian) brachiopod fauna from Gegyai County, northwestern Xizang (Tibet) and its biogeographic significance. *In*, Sun, D., Xu, J. *et al.*, *Stratigraphy and Palaeontology of Permian, Jurassic and Cretaceous from the Rutog Region, Xizang (Tibet)*, p. 215–275, pls. 1–7, Nanjing University Press, Nanjing. (*in Chinese*)

Tanase, A. and Kasahara, Y., 1988: Northern Takayama area; Hida Gaien Belt. *In*, Yamashita, N., Kaseno, Y. and Itoigawa, J. eds., *Geology of Japan, vol. 5. Chubu-Chiho, pt. 2*, p. 20–21, Kyoritsu Shuppan, Tokyo. (*in Japanese*)

Tazawa, J., 1974a: Two species of *Permundaria* from the Kitakami Mountains, northeast Japan. *Transactions and Proceedings of the Palaeontological Society of Japan, N. S.*, no. 94, p. 313–318, pl. 43.

Tazawa, J., 1974b: *Waagenoconcha* (Brachiopoda) from the Permian of the southern Kitakami Mountains, northeast Japan. *Journal of the Faculty of Science, Hokkaido University, Ser. 4*, vol. 16, nos. 2, 3, p. 121–143, pls. 1–4.

Tazawa, J., 1976: The Permian of Kesennuma, Kitakami Mountains: A preliminary report. *Earth Science (Chikyu Kagaku)*, vol. 30, no. 3, p. 175–185, pls. 1–3.

Tazawa, J., 1979: Middle Permian brachiopods from Matsukawa, Kesennuma region, southern Kitakami Mountains. *Saito Ho-on Kai Museum Research Bulletin*, no. 47, p. 23–35, pls. 4, 5.

Tazawa, J., 1987: Permian brachiopod faunas of Japan and their palaeobiogeography. *Chikyu Monthly (Gekkan Chikyu)*, vol. 9, no. 5, p. 252–255. (*in Japanese*)

Tazawa, J., 1991: Middle Permian brachiopod biogeography of Japan and adjacent regions in east Asia. *In*, Ishii, K., Liu, X., Ichikawa, K. and Huang, B. eds., *Pre-Jurassic Geology of Inner Mongolia, China: Report of China-Japan Cooperative Research Group, 1987–1989*, p. 213–230, Matsuya Insatsu, Osaka.

Tazawa, J., 1996: Permian continental shelf deposits in the

Kitakami, Hida and Sikhote-Alin Mountains. *Chikyu Monthly (Gekkan Chikyu)*, vol. 18, no. 6, p. 387-392. (*in Japanese*)

Tazawa, J., 1998: Pre-Neogene tectonic divisions and Middle Permian brachiopod faunal provinces of Japan. *Proceedings of the Royal Society of Victoria*, vol. 110, nos. 1, 2, p. 281-288.

Tazawa, J., 1999a: Occurrence of the Boreal-type brachiopod *Yakovlevia* from the Middle Permian of the Hida Gaien and South Kitakami Belts, Japan and its tectonic implications. *Journal of the Geological Society of Japan*, vol. 105, no. 3, p. 227-230. (*in Japanese*)

Tazawa, J., 1999b: Boreal-type brachiopod *Yakovlevia* from the Middle Permian of Japan. *Paleontological Research*, vol. 3, no. 2, p. 88-94.

Tazawa, J., 2000: Permian brachiopod faunas and pre-Neogene tectonics in the Inner Side of southwest Japan. *Monograph* (*Chidanken Senpo*), no. 49, p. 5-22. (*in Japanese*)

Tazawa, J., 2001: Middle Permian brachiopod faunas of Japan and South Primorye, Far East Russia: their palaeobiogeographic and tectonic implications. *Geosciences Journal*, vol. 5, no. 1, p. 19-26.

Tazawa, J., Hasegawa, Y. and Yoshida, K., 2000: *Schwagerina* (Fusulinacea) and *Choristites* (Brachiopoda) from the Carboniferous Arakigawa Formation in the Hidagaien Belt, central Japan. *Earth Science* (*Chikyu Kagaku*), vol. 54, no. 3, p. 196-199. (*in Japanese*)

Tazawa, J. and Ibaraki, Y., 2001: Middle Permian brachiopods from Setamai, the type locality of the Kanokura Formation, southern Kitakami Mountains, northeast Japan. *Science Reports of Niigata University, Ser. E*, no. 16, p. 1-33, pls. 1-4.

Tazawa, J. and Matsumoto, T., 1998: Middle Permian brachiopods from the Oguradani Formation, Ise district, Hida Gaien Belt, central Japan. *Science Reports of Niigata University, Ser. E*, no. 13, p. 1-19, pls. 1, 2.

Tazawa, J., Ono, T. and Hori, M., 1998: Two Permian lyttoniid brachiopods from Akasaka, central Japan. *Paleontological Research*, vol. 2, no. 4, p. 239-245.

Tazawa, J., Takizawa, F. and Kamada, K., 2000: A Middle Permian Boreal-Tethyan mixed brachiopod fauna from Yakejima, southern Kitakami Mountains, NE Japan. *Science Reports of Niigata University, Ser. E*, no. 15, p. 1-21, pl. 1.

Tazawa, J., Tsushima, K. and Hasegawa, Y., 1993: Discovery of *Monodiexodina* from the Permian Moribu Formation in the Hida Gaien Belt, central Japan. *Earth Science* (*Chikyu Kagaku*), vol. 47, no. 4, p. 345-348. (*in Japanese*)

Termier, H. and Termier, G., 1960: Contribution à la classification des Brachiopodes: le lophophore des Collolophides nov. ord.; Appendice. Les Oldhaminidés du Cambodge. *Société Géologique de France, Bulletin, Sér. 7*, vol. 1, no. 3, p. 233-243, pls. 2, 3.

Thomas, G. A., 1957: Oldhaminid brachiopods in the Permian of northern Australia. *Journal of the Palaeontological Society of India*, vol. 2, p. 174-182, pl. 20.

Tong, Z., 1978: Carboniferous and Permian Brachiopoda. *In*, Geological Institute of Southwest China *ed., Palaeontological atlas of Southwest China; Sichuan, pt. 2. Carboniferous to Mesozoic*, p. 210-267, pls. 77-92, Geological Publishing House, Beijing. (*in Chinese*)

Toula, F., 1875: Permo-Carbon-Fossilien von der Westküste von Spitzbergen. *Neues Jahrbuch für Mineralogie, Geologie und Paläontologie, Jahrgang, 1875*, p. 225-264, pls. 5-10.

Tschernyschew, Th., 1888: Zametka o kamennougolnoy kollektsii iz okrestnostey Vladivostoka. *Izvestiya Geologicheskogo Komiteta*, vol. 7, no. 9, p. 353-359. (*in Russian*)

Tschernyschew, Th., 1902: Verkhnekamennougolnye brakhiopody Urala i Timana. *Trudy Geologicheskago Komiteta*, vol. 16, no. 2, p. 1-749, pls. 1-63. (*in Russian*)

Tschernyschew, Th., 1914: Fauna verkhnepaleozoyskikh otlozheniy Darvaza. *Trudy Geologicheskago Komiteta, N. S.*, vol. 104, p. 1-66, pls. 1-10. (*in Russian*)

Umeda, M. and Ezaki, Y., 1997: Middle Permian radiolarian fossils from the acidic tuffs of the Kanayama and Fukuji areas in the Hida "Gaien" Terranes, central Japan. *Fossils* (*Kaseki*), no. 62, p. 37-44. (*in Japanese*)

Ustritsky, V.I., 1960: Permskie brakhiopodi Pay-Khoya (Inarticulata, Strophomenidae i Chonetidae). *Trudy NIIGA*, vol. 111, p. 93-124, pls. 1-6. (*in Russian*)

Ustritsky, V.I. and Tschernjak, G.E., 1963: Biostratigrafiya i brakhiopodi verkhnego paleozoya Taymira. *Trudy NIIGA*, vol. 134, p. 1-139, pls. 1-47. (*in Russian*)

Verneuil, E. de, 1845: Paléontologie, Mollusques, Brachiopodes. *In*, Murchison, R. I., Verneuil, E. de and Keyserling, A. de, *Géologie de la Russie d'Europe et des Montagnes de l'Oural*, p. 37-294, pls. 1-18, John Murray, London and Bertrand, Paris.

Volgin, V.I., 1960: *Brakhiopody verknekamennougolnykh i nizhnepermskikh otlozheniy Yuzhnoy Fergany*, 203 p., 18 pls. Izdatelstvo Leningradskogo Universiteta, Leningrad (*in Russian*)

Waagen, W., 1882: Productus-Limestone fossils. *Palaeontologia Indica, Ser. 13*, vol. 1, pt. 4, fasc. 1, p. 329-390, pls. 25-28.

Waagen, W., 1883: Productus-Limestone fossils. *Palaeontologia Indica, Ser. 13*, vol. 1, pt. 4, fasc. 2, p. 391-546, pls. 29-49.

Waagen, W., 1884: Productus-Limestone fossils. *Palaeontologia Indica, Ser. 13*, vol. 1, pt. 4, fascs. 3, 4, p. 547-728, pls. 50-81.

Waagen, W., 1885: Productus-Limestone fossils. *Palaeontologia Indica, Ser. 13*, vol. 1, pt. 4, fasc. 5, p. 729-770, pls. 82-90.

Wang, C. and Yang, S., 1998: *Late Carboniferous-Early Permian brachiopods of central Xinjiang and their biostratigraphical studies*, 156 p., 24 pls., Geological Publishing House, Beijing. (*in Chinese*)

Wang, G., Liu, Q., Jin, Y., Hu, S., Liang, W. and Liao, Z., 1982: Phylum Brachiopoda. *In*, Nanjing Institute of Geology and Mineral Resources *ed., Palaeontological Atlas of East China, pt. 2. Late Palaeozoic Volume*, p. 186-256, pls. 74-102, Geological Publishing House, Beijing. (*in Chinese*)

Wang, Y., Jin, Y. and Fang, D., 1964*: Brachiopod fossils of China, pt. 1*, 354 p., 58 pls., Science Press, Beijing. (*in Chinese*)

Wanner, J. and Sieverts, H., 1935: Zur Kenntnis der permischen Brachiopoden von Timor, 1. Lyttoniidae und ihre biologische und stammes geschichtliche Bedeutung. *Neues Jahrbuch für Mineralogii,*

Geologie und Paläontologie, vol. 74, p. 201-281, pls. 6-9.

Waterhouse, J. B., 1968: New spcies of *Megousia* Muir-Wood and Cooper and allied new genus from the Permian of Australia and North America. *Journal of Paleontology*, vol. 42, no. 5, p. 1171-1185, pls. 154-156.

Waterhouse, J. B., 1975: New Permian and Triassic brachiopod taxa. *Department of Geology, University of Queensland, Papers*, vol. 7, no. 1, p. 1-23, pls. 1, 2.

Waterhouse, J. B. and Piyasin, S., 1970: Mid-Permian brachiopods from Khao Phrik, Thailand. *Palaeontographica, Abt. A*, vol. 135, p. 83-197, pls. 14-31.

Waterhouse, J. B. and Waddington, J., 1982: Systematic descriptions, paleoecology and correlations of the late Paleozoic subfamily Spiriferellinae (Brachiopoda) from the Yukon Territory and the Canadian Arctic Archipelago. *Geological Survey of Canada, Bulletin*, 289, p. 1-73, pls. 1-8.

Waterhouse, J. B., Waddington, J. and Archbold, N., 1978: The evolution of the Middle Carboniferous to Late Permian brachiopod subfamily Spiriferellinae Waterhouse. *Geological Association of Canada, Special Paper*, 18, p. 415-443, pls. 1-3.

Yabe, H., 1900: The brachiopod *Lyttonia* from Rikuzen Province. *Journal of the Geological Society of Tokyo*, vol. 7, no. 79, p. 1-4.

Yamada, K. and Yamano, H., 1980: Find of Permian fossils from the Moribu Formation, Hida Mountains, central Japan. *Science Reports, Kanazawa University*, vol. 25, no. 1, p. 53-65, pls. 1, 2.

Yanagida, J., 1963: Brachiopods from the Upper Permian Mizukoshi Formation, central Kyushu. *Memoirs of the Faculty of Science, Kyushu University, Ser. D*, vol. 14, no. 2, p. 69-78, pls. 8-10.

Yanagida, J., 1967: Early Permian brachiopods from north-central Thailand. *Geology and Palaeontology of Southeast Asia*, vol. 3, p. 46-97, pls. 11-23.

Yanagida, J. 1970: Permian brachiopods from Khao Phrik, near Rat Buri, Thailand. *Geology and Palaeontology of Southeast Asia*, vol. 8, p. 69-96, pls. 14-16.

Yanagida, J., 1996: Permian brachiopods from the Tsunemori Formation, SW Japan, and their paleobiogeographic implication. *In*, Copper, P. and Jin, J. *eds., Brachiopods*, p. 313-315, A. A. Balkema, Rotterdam.

Yanagida, J. and Nakornsri, N., 1999: Permian brachiopods from the Khao Hin Kling area near Phetchabun, north-central Thailand. *Bulletin of the Kitakyushu Museum of Natural History*, no. 18, p. 105-136, pls. 26-32.

Yang, D., 1984: Systematic description of palaeontology; Brachiopoda. *In*, Yichang Institute of Geology and Mineral Resources *ed., Biostratigraphy of the Yangtze Gorge Area, vol. 3*, p. 203-239, 330-333, pls. 29-38, Geological Publishing House, Beijing. (*in Chinese*)

Yang, D., Ni, S., Chang, M. and Zhao, R., 1977, Phylum Brachiopoda. *In*, Geological Institute of Hubei *et al. eds., Palaeontological Atlas of South-central China, pt. 2. Late Palaeozoic Volume*, p. 303-470, pls. 130-188, Geological Publishing House, Beijing (*in Chinese*)

Yang, S. and Gao, J., 1996: Systematic description: Brachiopods. *In*, Zeng, X., Zhu, W., He, X., Teng, F. *et al., Permo-Carboniferous Biostratigraphy and Sedimentary Environment of West Qinling*, p. 211-218, 271-274, pls. 30-35, Geological Publishing House, Beijing. (*in Chinese*)

Yang, Z., Ting (Ding), P., Yin, H., Zhang, S. and Fang, J., 1962: Carboniferous, Permian and Triassic brachiopod faunas from Chilianshan region. *In*, Institute of Geology and Palaeontology, Geological Institute, Academia Sinica and Beijing University of Geology *eds., Monograph on geology of Chilianshan Mountains, vol. 4, pt. 4*, 129 p., 48 pls., Science Press, Beijing. (*in Chinese*)

Yoshida, K. and Tazawa, J., 2000: Sandstone composition and provenance of the Permian Moribu Formation in the Hida Marginal Belt, central Japan. *Memoirs of the Geological Society of Japan*, no. 57, p. 53-62. (*in Japanese*).

Zavodovskiy, V.M., 1968: Otryad Spiriferida. *In*, Markovskiy, B. P. *ed., Novye vidy drevnikh rasteniy i bespozvonochnykh SSSR, vol. 2*, p. 149-160, pls. 42-46, Nedra, Moskva. (*in Russian*)

Zeng, Y., 1990: Description of brachiopods. *In*, He, X., Zhang, Y., Zhu, M., Zhang, G., Zhuang, S., Zeng, Y. and Song, P., *Research on the Late Paleozoic Coal-bearing Stratigraphy and Biota in Jungar, Nei Mongol (Inner Mongolia)*, p. 205-238, pls. 1-8, China University of Mining and Technology Press, Xuzhou. (*in Chinese*)

Zhan, L., 1979: Descriptions of fossils; Brachiopoda. *In*, Hou, H., Zhan, L., Chen, B. *et al., The Coal-bearing Strata and Fossils of Late Permian from Guangtung*, p. 61-100, pls. 4-13, Geological Publishing House, Beijing. (*in Chinese*)

Zhan, L. and Wu, R., 1982: Early Permian brachiopods from Xainza district, Xizang (Tibet). *In*, CGQXP Editorial Committee, Ministry of Geology and Mineral Resources *ed., Contribution to the geology of the Qinghai Xizang (Tibet) Plateau, vol. 7*, p. 86-109, pls. 1-6, Geological Publishing House, Beijing. (*in Chinese*)

Zhang, Y. and Ching, Y., 1961: An Upper Permian Brachiopoda fauna from Jingxian, Anhui Province. *Acta Palaeontologica Sinica*, vol. 9, no. 4, p. 401-417, pls. 1-4. (*in Chinese*)

Zhang, C., Zhang, F., Zhang, Z. and Wang, Z., 1983: Phylum Brachiopoda. *In*, Regional Geological Survey Team of Xinjiang, Institute of Geoscience of Xinjiang and Geological Survey Group of Petroleum Bureau of Xinjiang *eds., Palaeontological Atlas of Southwest China; Xinjiang part, pt. 2. Late Palaeozoic Volume*, p. 262-386, pls. 86-145, Geological Publishing House, Beijing. (*in Chinese*)

Zhu, T., 1990: *The Permian coal-bearing strata and palaeobiocoenosis of Fujian*, 127 p., 47 pls., Geological Publishing House, Beijing (*in Chinese*)

Ziegler, A. M., Hulver, M. L. and Rowley, D. B., 1996: Permian world topography and climate. *In*, Martini, I. P., *ed., Late glacial and Postglacial Environmental Changes - Quaternary, Carboniferous-Permian and Proterozoic*, p. 1-37, Oxford University Press, New York.